



**REMEDIAL ALTERNATIVES TECHNICAL MEMORANDUM**

**OMC PLANT 2  
Waukegan, Illinois**

**Remedial Investigation/Feasibility Study**

**WA No. 237-RICO-0528/Contract No. 68-W6-0025**

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- A Evaluation of ARARs
- B Sewer Sampling and Results

# Acronyms and Abbreviations

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°F	Degrees Fahrenheit
µg/100 cm <sup>2</sup>	micrograms per 100 square centimeters
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ACM	asbestos-containing material
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	contaminant of concern
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
ELCR	excessive lifetime cancer risk
EO	Executive Order
EPRI	Electric Power Research Institute
ERA	ecological risk assessment
ERH	electrical resistive heating
FR	Federal Register
FS	feasibility study
FSP	field sampling plan
ft/ft	foot per foot
g/kg	grams per kilogram
GAC	granular activated carbon
HHRA	human health risk assessment
HI	hazard index
IAC	Illinois Administrative Code
IC	institutional control
IEPA	Illinois Environmental Protection Agency
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction

ISTD	in situ thermal desorption
IWQS	Illinois Water Quality Standards
LDR	land disposal restriction
MCL	maximum contaminant limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIP	membrane interface probe
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	operations and maintenance
OMC	Outboard Marine Corporation
OU1	Operable Unit 1
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
POTW	publicly owned treatment works
ppm	parts per million
PRG	preliminary remediation goal
RAO	remedial action objective
RATM	Remedial Alternatives Technical Memorandum
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SOW	statement of work
SPH	Six-Phase Heating™
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TACO	Tiered Approach to Cleanup Objectives
TBC	to be considered
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TMV	toxicity, mobility, or volume
TSCA	Toxic Substance Control Act
USEPA	United States Environmental Protection Agency
UST	underground storage tank

UTS	Universal Treatment Standard
UV	ultraviolet
VOC	volatile organic compound
WA	Work Assignment
WCP	Waukegan Coke Plant
ZVI	zero valent iron

## SECTION 1

# Introduction

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## 1.1 Purpose

This Remedial Alternatives Technical Memorandum (RATM) presents the results of the remedial action objectives development, technology screening, and alternative development completed for the Outboard Marine Corporation (OMC) Plant 2 site in Waukegan, Illinois. The work is being performed for the U.S. Environmental Protection Agency (USEPA) in accordance with the statement of work (SOW) for Work Assignment (WA) No. 237-RICO-0528.

The technology screening constitutes Task 10 in the SOW and is the first task of three tasks (Tasks 10, 11, 12) that will comprise the feasibility study (FS) for the site. Task 11 is the remedial alternatives evaluation, in which the remedial alternatives developed in this RATM are defined to support a cost estimate and analyzed individually and against each other. Task 12 is the FS report.

As described in Task 10 in the SOW and the remedial investigation (RI)/FS work plan (CH2M HILL, 2004a), those alternatives that will remediate or control contaminated media (building materials, soil/sediment, and groundwater) remaining at the site to provide adequate protection of human health and the environment were evaluated. The potential alternatives encompass, as specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume (TMV) of wastes, but vary in the degree to which long-term management of residuals or untreated waste is required.

The general objectives of this RATM include the following:

- Identify site-specific remedial action objectives
- Develop general response actions for each medium of interest
- Identify and screen applicable remedial technologies for effectiveness, implementability, and cost
- Develop remedial alternatives in accordance with the NCP

## 1.2 Organization

This RATM consists of four sections. Section 1 provides an introduction and summarizes background information, such as site physical description, previous removal actions, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, and the human health and ecological risks.

The development of the remedial action objectives (RAOs) and preliminary remediation goals (PRGs) are discussed in Section 2. Chemical-specific remedial goals were developed

for the building materials, soil/sediment, and groundwater based on risk associated with the various concentrations of contaminants in those media, the applicable or relevant and appropriate requirements (ARARs), and background concentrations when applicable. A detailed review of ARARs for this site is provided in Appendix A.

Section 3 contains information about the general response actions that address the RAOs and introduces the identification and screening of the technology types and process options. Remedial technologies were screened to focus the detailed analysis on only those technologies most applicable to the site.

In Section 4, the screened technologies were developed into remedial action alternatives that achieve some or all of the RAOs and provide a range of levels of remediation.

Reference documents used during the performance of the alternatives screening and preparation of this memorandum are included in Section 5.

## **1.3 Site Description**

The following sections briefly describe the physical location of the site; its operational history; the geologic, hydrogeologic, and ecological setting; the nature and extent of contamination; contaminant fate and transport; and summary of human health and ecological risks. Additional information on the site is presented in the Field Sampling Plan (FSP; CH2M HILL, 2004b) and the Remedial Investigation Report (CH2M HILL, 2005).

### **1.3.1 Site Location**

The OMC Plant 2 site is located at 100 E. Seahorse Drive, Waukegan, Illinois (Figure 1-1). The 65-acre site includes a 1,036,000-square foot former manufacturing plant building (Plant 2) and several parking lot areas to the north and south of the building complex (Figure 1-2). The site includes two polychlorinated biphenyl (PCB) containment cells in which PCB-contaminated sediment (dredged from Waukegan Harbor in the early 1990s) and PCB-impacted soil are managed. The cells (the East Containment Cell and the West Containment Cell) are located north of the plant building.

The site is situated in an area of mixed industrial, recreational, and municipal land uses (Figure 1-2). The OMC facility is bordered to the north by the North Ditch and North Shore Sanitary District and to the east by the public beach and dunes along Lake Michigan. Seahorse Drive forms the southern site boundary. Railroad tracks operated by the Elgin, Joliet, and Eastern Railway Company, and the A. L. Hanson Manufacturing Company (formerly OMC Plant 3) are located to the west of OMC Plant 2.

### **1.3.2 Background**

OMC designed, manufactured, and sold outboard marine engines, parts, and accessories to a worldwide market for many years. Plant 2 was a main manufacturing facility for OMC-the major production lines used PCB-containing hydraulic and lubricating/cutting oils, chlorinated solvent-containing degreasing equipment, and smaller amounts of hydrofluoric acid, mercury, chromic acid, and other similar chemical compounds.

OMC filed for bankruptcy protection on December 22, 2000, and later abandoned the property after completing a limited removal action. In November 2001, the bankruptcy trustee filed a motion to abandon OMC Plant 2. The bankruptcy trustee negotiated an emergency removal action scope of work with USEPA and Illinois Environmental Protection Agency (IEPA) that was approved by the court on July 17, 2002. The waste removal activities for the OMC Trust were completed in November 2002 and the Trust abandoned the OMC Plant 2 property on December 10, 2002.

USEPA assumed control of building security and utilities on December 10, 2002, and commenced a removal action to clean up more of OMC Plant 2 in spring 2003.

The City of Waukegan took title to the OMC Plant 2 property in July 2005 and is responsible for maintaining the building, property, and operation and maintenance (O&M) of the containment cells.

### **1.3.3 Previous Remediation and Removal Actions**

Since the late 1970s, the OMC Complex has been subject to investigation and remediation (primarily for PCBs). The information on the remedial activities conducted at the site is briefly summarized below.

#### **Waukegan Harbor Remediation**

Reports indicate that from 1961 to 1972 OMC purchased about 8 million gallons of hydraulic fluid containing PCBs to use as a lubricant in its aluminum die casting machines. During the manufacturing process, some of the hydraulic fluid spilled into floor drains that discharged to an oil interceptor system. As a result, large quantities of PCBs were released directly to Waukegan Harbor in the western end of former Slip 3 and on the OMC property into the North Ditch, Oval Lagoon, Crescent Ditch, and the parking lot. By the time the discharge pipe to the harbor was sealed in 1976, about 300,000 pounds of PCBs had been released into the Waukegan Harbor and another 700,000 pounds to the OMC property near the North Ditch (USEPA, 2002).

In September 1983, Waukegan Harbor and the North Ditch area (Operable Unit 1 [OU1] and OU3) were placed on the National Priorities List (NPL). OMC financed a trust to implement the cleanup and to ensure performance of the requirements of the Consent Decree with USEPA (dated April 1989). The final remedy included the following (USEPA, 2002):

- Construction of cutoff walls to isolate PCB-contaminated materials and to make Slip 3 a permanent containment cell. Designated dredged harbor sediments were placed in Slip 3 for containment.
- Excavation and construction of a new boat slip (Slip 4) on the east side of the North Harbor on the Waukegan Coke Plant (WCP) property for the relocation of Larsen Marine Service from Slip 3.
- Construction of two other containment cells (termed the East and West Containment Cells) on the OMC Plant 2 property (Figure 1-2). The East Containment Cell encompasses the Plant 2 parking lot area and the land east of the lot. The West Containment Cell encompasses the Crescent Ditch and Oval Lagoon. Before construction, all areas containing PCB contamination at concentrations greater than 10,000 parts per million (ppm) were excavated and removed for treatment. Soil

excavated from the parking lot area did not require treatment before placement into the East Containment Cell because it did not exceed the treatment criterion. About 5,000 cubic yards of sediment and soil were removed from the North Ditch, 2,900 cubic yards from Oval Lagoon, and 3,800 cubic yards from Crescent Ditch.

- Placement of residual soils from the treatment of materials in hot spot areas by a low-temperature extraction procedure into the West Containment Cell, which was then closed and capped.
- Restoration of the North Ditch by excavation of designated sediments, placement of these sediments in the West Containment Cell, and backfilling of the North Ditch with clean sand.
- Installation and operation of an extraction well system at each containment cell to prevent the migration of PCBs from the cells by maintaining an inward hydraulic gradient. Treatment of extracted water using dedicated water treatment systems with discharge to the North Ditch or Waukegan Harbor.

Final construction activities for the Waukegan Harbor (OU1 and OU3) remedial action were completed in December 1994. O&M of the containment cells is ongoing.

### **UST and AST Investigations and Remediation**

As a result of a tightness test that detected a leak in underground storage tank (UST) Tank 2.6, OMC removed six USTs in 1993 and performed a closure assessment. The closure assessment report indicates that five of the tanks were in good condition upon removal. Two small holes were observed in the bottom of Tank 2.6. On the basis of soil staining, strong petroleum odors, and sheen on groundwater entering the excavation, IEPA was notified that a release had occurred (Sigma, 1993).

### **OMC's Removal Action**

The waste removal activities for the OMC Trust were conducted beginning in August 2002 and were completed in November 2002. The completed tasks included removing and disposing of all drums and containers, draining of all tanks, draining and flushing of all transformers, draining and disposing of all hydraulic fluid remaining in machines, draining and disposing of all fluids in the chip wringer and hopper machine, and removing and disposing of all batteries and capacitors. The OMC Trust abandoned the Plant 2 property on December 10, 2002.

### **USEPA Removal Action**

USEPA assumed control of building security and utilities on December 10, 2002, and commenced a removal action between May 12 and July 11, 2003. USEPA's activities consisted of waste removal, floor decontamination, site security, O&M of the sediment containment cells, tunnel inspections, soil and groundwater sampling, asbestos removal, and draining and disposal of PCB-contaminated transformer fluid. Wastes removed included hydraulic oil, machining oil, oily metal chips, sludge, compressed gasses, and waste decontamination water. The chip wringer pit, metal working floor, former parts storage area floor, and floor in the old die cast area were cleaned. Floor decontamination efforts reduced PCB concentrations on the floors, but remaining concentrations exceed

standards in five of nine metal working area wipe samples collected following floor cleaning (Tetra Tech, 2003).

Friable asbestos-containing material (ACM) was identified on three pressure vessels in the north boiler room and was targeted for removal. ACM associated with venting and external piping in the western part of the plant also was removed (Tetra Tech, 2003).

OMC had numerous PCB transformers that were mounted on the roof or on pads in the building and equipped with curbing. Seven PCB capacitors were reportedly also located within the Plant 2 facility. Transformers were drained and replaced with non-PCB containing fluid during removal activities conducted by the OMC Trust in 2002. After 90 days of use, USEPA sampled 23 of the plant's transformers that were historically filled with PCB-containing dielectric fluids and found PCB concentrations (ranging from 9,600 to 59,000 milligrams per kilogram [mg/kg]), which still exceeded regulatory limits. As part of USEPA's removal activities in July 2003, the electrical transformers were de-energized and the PCB-containing fluid was drained from all except one of the transformers. After being drained, the plugs were replaced and the transformers were left empty with the power disconnected. One transformer (#8) was left full of fluid and energized because it was determined that the transformer supplied the Plant 2 guard house, phone, and fire alarm systems with power.

### **Assessment of the Lakefront Study Area**

The City of Waukegan conducted an environmental site investigation of the lakefront study area in July and October 2004 and May 2005. PCBs were detected over most of the dune area at depths of up to 8 feet. Elevated concentrations of PCBs (greater than 1 mg/kg) were in the northern portion of the study area, especially east of the East Containment Cell. This area south of the North Ditch and east of the containment cell include three locations containing PCB concentrations greater than 100 mg/kg. The City's investigation results estimate that there is approximately 3,300 cubic yards of material with PCB concentrations greater than 10,000 µg/kg in this area (Deigan and Associates, LLC., 2004).

In August 2005 the USEPA Emergency Response Branch collected additional soil samples from the dune area east of the main plant in response to the PCB concentrations in soils detected during the City of Waukegan's investigation. Sample locations were selected to coincide with locations sampled by the City of Waukegan or to provide better resolution of potential excavation areas. Samples collected by USEPA in August 2005 confirm the PCB concentrations detected by the City of Waukegan (Tetra Tech, 2005).

### **1.3.4 Remedial Investigation**

OMC and USEPA have conducted multiple investigations at the site and in its vicinity. Since the late 1970s, a large body of geologic, hydrogeologic, hydrologic, and chemical distribution information has been developed during investigations conducted. The data needs and investigation approach for the site were developed based on the conceptual model developed from the existing data, potential environmental issues, and future land use goals. The field investigation was conducted at the OMC Plant 2 site between January and June 2005. The data collection activities included the following:

- An investigation of the building materials including collection of PCB wipe samples from porous and nonporous surfaces and concrete core samples to evaluate material handling and disposal options.
- An investigation of the storm sewers to determine if they continue to discharge to Waukegan Harbor.
- Surface and subsurface soil sampling to define the nature and extent of contamination within the footprint of the building and surrounding areas.
- A membrane interface probe (MIP) investigation to delineate the extent of volatile organic compounds (VOCs) in the subsurface.
- Monitoring well installation and groundwater sampling to verify groundwater quality conditions, including data to determine if conditions are conducive for natural attenuation.
- An investigation to determine the extent of the dense nonaqueous phase liquid (DNAPL) encountered during the MIP investigation.

In addition to the CH2M HILL field investigations, the City of Waukegan and USEPA also collected soil samples from the dune area to the east of the site. Additional wipe sampling was also conducted in August within the Triax Building by Conestoga-Rovers & Associates for the Waukegan Coke Plant Settling Defendants. These data were incorporated into the nature and extent of contamination and risk assessment discussions presented in the RI report.

## **1.4 Physical Site Setting**

### **1.4.1 Local Demography and Land Use**

#### **Current Conditions**

The current land use in the vicinity of OMC Plant 2 is primarily marine-recreational and industrial, but also includes utilities and a public beach east of the site (Figure 1-2). Waukegan Harbor, south of the site, is an industrial and commercial harbor used by lake-going freighters and recreational boaters. The Larsen Marine Service property lies between the OMC Plant 2 site and Waukegan Harbor. Larsen Marine Service uses Slip 4 for repair, supply, and as docking facilities for private boats.

The Lake County Board and the City of Waukegan classified land use areas in Lake County in 1987. Land surrounding the northern portion of Waukegan Harbor is classified as urban, while the beach areas and water filtration plant properties are classified as open-space areas. The remaining land in the immediate harbor area is classified as special use (Lake County) or residential (City of Waukegan).

The site, surrounding properties, and the City of Waukegan obtain potable water from Lake Michigan. The city has no municipal potable wells. There are some private residential wells within the city limits at a distance from the site (URS, 2000).

## Future Land Use

In December 2000, OMC declared Chapter 11 bankruptcy, and began liquidation in August 2001. Subsequently, the City of Waukegan purchased the WCP site and also acquired the OMC Plant 2 property (Figure 1-2). The WCP and the OMC Plant 2 sites were rezoned to high-density-residential, and the City and other entities are working to revitalize the Waukegan lakefront area.

In December 2003, the City of Waukegan amended its 1987 Comprehensive Plan to include the Waukegan Lakefront - Downtown and Lakefront Master Plan and supporting documents prepared by Skidmore, Owings & Merrill, LLP and its consulting team (City of Waukegan Ordinance No. 03-O-140). The master plan and documents provided by the City of Waukegan were reviewed with respect to the anticipated future land use of OMC Plant 2 and surrounding properties. The plan defines the northern portion of the OMC Plant 2 property as an “eco-park” development that transitions to mixed-use marina-related commercial and residential use on the southern portion of the property. Similar plans are anticipated for the WCP site. The City is in the early stages of its process of rezoning various lakefront parcels consistent with the master plan (Deigan, 2004). A concept of the City’s vision for the harbor area is presented in Figure 1-3.

### 1.4.2 Geologic Setting

The subsurface materials encountered include near-surface fill materials above a naturally occurring sand unit that overlies clay till. The fill deposit extends from 2 to 12 feet below ground surface (bgs). Underlying the fill is a poorly graded sand or silty sand to a depth of about 25 to 30 feet. This relatively permeable sand unit comprises an unconfined aquifer with a geometric mean hydraulic conductivity of about  $2.0 \times 10^{-2}$  centimeters per second (cm/sec) and an average porosity of about 30 percent. Beneath the sand unit is 70 to 80 feet of hard gray clay that forms the lower boundary of the unconfined aquifer.

### 1.4.3 Hydrogeologic Setting

Groundwater is shallow and was encountered at depths ranging between 2 and 7 feet, depending on the ground surface elevation. Groundwater flow is generally west to east across the northern portion of the site (toward Lake Michigan) and in the southern portion of the site groundwater flows toward the south (toward Waukegan Harbor). The horizontal gradient is flat beneath the building and increases toward the south. The overall average site gradient is estimated to be 0.002 foot per foot (ft/ft). The calculated groundwater velocities ranged from about 70 to 150 feet/year in the shallow zone and 6 to 30 feet/year in the deeper zone of the aquifer. The overall site average groundwater velocity is estimated to be about 70 feet/year. Vertical gradients between the shallow and the deeper portions of the aquifer are almost non-existent.

### 1.4.4 Ecological Setting

The most significant ecological feature is the 13-acre area on the easternmost side of the OMC Plant 2 property, extending from the North Shore Sanitary District’s southern property boundary including the North Ditch to the South Ditch (Figure 1-2). This portion of Waukegan Beach has never been developed with surface structures and is generally inaccessible. Wooded areas have been re-established east of the former seawall barrier and

extend from the North Ditch to the South Ditch. Most of the remaining portions of the Waukegan Beach east of this tree line are rolling sand dunes with sporadic tree and natural grass land cover that lead eastward to a gently sloping beach.

Three wetland areas are represented by drainage ditches on the north and south edges of the area and by a small depression along the North Ditch near the lakeshore. A narrow terrace along the north side of the South Ditch contained significant amounts of conservative wetland species.

The Illinois Department of Natural Resources identified 13 plants species, 1 invertebrate species, and 5 bird species that are threatened or endangered (federal or state) and occur within 1 mile of OMC Plant 2 (Kieninger, 2005). The piping plover is the only threatened or endangered (federal or state) bird species known to have nested in the beach area east of the OMC Plant 2 site (IEPA, 1994). Four threatened or endangered plant species have been found at Waukegan Beach. The species are American sea rocket (*Cakile edentula*; state-threatened), seaside spurge (*Chamaesyce polygonifolia*; state-endangered), American beachgrass (*Ammophila breviligulata*; state-endangered), and Kalm's St. John's wort (*Hypericum kalmianum*; state-endangered).

## **1.5 Nature and Extent of Contamination**

The findings of the field investigation relative to the nature and extent of contamination at the OMC Plant 2 site are described below.

### **1.5.1 Building Materials and Sewer Testing**

The OMC Plant 2 building materials were sampled to evaluate material handling and disposal options. During removal activities conducted by USEPA, PCB contamination was identified in the old die cast, parts storage, and metal working areas. Building materials were grouped and sampled according to surface material porosity as defined in 40 Code of Federal Regulations (CFR) 761.

#### **Nonporous Surfaces—Metal Structures and Piping**

Analytical results from wipe sampling indicate nonporous metal surfaces with concentrations of PCBs exceeding the 10 micrograms per 100 square centimeter ( $\mu\text{g}/100\text{ cm}^2$ ) Toxic Substance Control Act (TSCA) disposal criteria are present throughout the OMC Plant 2 building, with the exception of the northeast corner of the metal working area where no nonporous surfaces were present. In addition, nonporous surfaces in the old die cast, parts storage, and metal working areas have concentrations of PCBs exceeding the second-tier TSCA disposal criteria of  $100\text{ }\mu\text{g}/100\text{ cm}^2$ .

PCBs were detected in nonporous samples throughout all sampled building areas, but at wide-ranging concentrations. The general trend of detected PCBs on nonporous surfaces indicates the highest concentrations in the old die cast and parts storage areas with concentrations decreasing outward from these areas.

## **Porous Floor**

Samples collected from concrete floors within the OMC Plant 2 building indicate the presence of PCBs at concentrations exceeding the 50 mg/kg TSCA disposal criteria established in 40 CFR 761. The distribution of PCBs in concrete generally coincides with wipe sample results in the old die cast and parts storage areas, which have the highest detected concentrations that decrease outward. Concentrations of PCBs exceeding 50 mg/kg appear to be limited to concrete floors in the old die cast and parts storage areas or to approximately 25 percent of the total building floor area. Concentrations of PCBs below 50 mg/kg were detected in concrete floors in all areas of the plant.

## **Porous Surfaces Other Than Floors**

Wipe sample results for porous surfaces other than floors indicate PCBs were detected in the old die cast, parts storage, and metal working areas of the OMC Plant 2 building. Paint chip and concrete samples were collected to determine disposal requirements for the materials where concentrations greater than 10 µg/100 cm<sup>2</sup> were detected in wipe samples from porous surfaces. Concentrations of PCBs exceed the TSCA disposal criteria for solids of 50 mg/kg in eight of the ten concrete and paint chip samples.

## **Sewer Testing**

Sediment samples were collected from select manholes south of the OMC building. Sediment sampling was performed prior to completion of remedial investigation activities; however, analytical results from the sewer samples were not available until after completion of the remedial investigation.

The manholes west of the corporate building to the Triax Building were found to contain varying amounts of standing water and large volumes of sediment. The plugging of the storm sewer pipe appears to be effectively preventing discharge directly to Waukegan Harbor.

Sediment samples were collected for PCB analysis from seven storm sewer locations located south of OMC Plant 2. Sediment generally consisted of silty sand with trace organics and ranged from 4 to 30 inches in thickness. PCBs were detected in all of the sediment samples ranging from 0.2 to 130 mg/kg. Concentrations of PCBs greater than 1 mg/kg were detected in the storm sewer manholes located east of the corporate building and just north of East Seahorse Drive. The storm sewer in this area is reported to discharge to the east into the South Ditch or may extend south beneath the Larsen Marine Service property and discharge to Waukegan Harbor. The sampling procedures and results are provided in Appendix B.

## **1.5.2 Soil and Sediment**

A limited soil investigation was conducted to fill in data gaps identified based on the evaluation of existing data. Concentrations of PCBs and carcinogenic polynuclear aromatic hydrocarbons (PAHs) that exceed the TSCA self-implementing PCB cleanup level of 1 mg/kg (or 1 ppm) were found in shallow soil. Elevated PCB concentrations exceeding 1 ppm were detected across the site and in the dune area east of the plant. The majority of PCB concentrations in the soil beneath the plant were consistent with where the wipe and concrete core samples indicated the presence of PCBs.

The results indicate that the majority of the most contaminated soils were removed as part of OMC's remediation north of the building. The additional areas containing PCB- and/or carcinogenic PAH-contaminated soil include north of the plant in the vicinity of former loading docks and tank areas, and in the open area north of the trim building, the former die cast UST/aboveground storage tank (AST) area, and the dune area east of the plant. Elevated concentrations of carcinogenic PAHs were also found in the area surrounding the corporate building.

### **1.5.3 Dense Nonaqueous Phase Liquids**

DNAPL was encountered at one location and was comprised of 1,600 grams per kilogram (g/kg) of trichloroethene (TCE). The extent of the DNAPL was investigated and not found at locations 50 feet around the MIP-027/SO-057 location. Concentrations of TCE indicative of residual DNAPL were detected in a saturated soil sample collected from a boring in the area of the chip wringer.

### **1.5.4 Groundwater**

Groundwater contamination is mainly related to the use of chlorinated solvents, primarily TCE, in manufacturing operations at OMC Plant 2. The MIP, soil, and groundwater investigations indicated that the distribution of chlorinated volatile organic compounds (CVOCs) is limited in extent and appears as isolated areas rather than a single plume. The MIP investigation identified five areas of which three were confirmed by the soil and groundwater results. The CVOC plume extending south of the building does not appear to have migrated far offsite and does not extend to Waukegan Harbor. The components of the CVOC concentrations include TCE, cis-1,2-dichloroethene (1,2-DCE), and vinyl chloride. The presence of TCE degradation compounds and results of natural attenuation parameters indicate that the TCE area is being degraded by anaerobic reductive dechlorination.

### **1.5.5 Soil Gas and Indoor Air**

Soil gas and indoor air sampling investigations were conducted to determine if volatilization from the groundwater plume may cause a potential inhalation risk to human health. Five soil gas samples were collected from the unsaturated zone at locations south of the OMC site in the vicinity of Larsen Marine Service. In addition to the soil gas samples, indoor air samples were collected from two of the Larsen Marine Service buildings.

In general, similar compounds were detected in the indoor air investigation as were found in the soil gas investigation results. The relative concentrations of OMC-related compounds (e.g., TCE and cis-1,2-DCE) and the predominance of compounds not detected in the groundwater samples indicate that volatilization from groundwater is probably not the major source of the VOCs detected in the soil gas samples or the indoor air samples from the Larsen Marine Service buildings.

## **1.6 Contaminant Fate and Transport**

The primary contaminant release and transport mechanisms occurring at the OMC Plant 2 site include the following:

- Volatilization of organic compounds from the building materials, soil and groundwater, and migration offsite through the atmosphere. Based on previous air sampling, PCBs may be volatilizing from the contaminated building material into the atmosphere. Volatilization of organic compounds from surface soil and groundwater is not considered a major loss mechanism based on physical properties of the surface materials.
- Leaching of contaminants from source materials, including DNAPL, into groundwater and subsequent dissolved phase transport to groundwater discharge areas such as surface water bodies (Lake Michigan or Waukegan Harbor) is considered the most significant transport mechanism occurring at the site.
- Surface runoff of contaminants to ditches, low lying areas, or surface water bodies by dissolving in stormwater runoff or by soil erosion. Based on the PCB contamination detected in the sediment in the North and South ditches, surface runoff has occurred in the past. Because of the site topography and the presence of the building, pavement, gravel, and vegetation covering most of the contaminated areas, the overall potential for continued transport of contaminated soils into offsite surface waters by erosion and surface flow is limited.
- The main contaminants in the surface soil (PCBs and carcinogenic PAHs) tend to be persistent in the environment because they are slow to degrade and have low mobility. The contaminants in the groundwater (CVOCs) have a higher mobility and are detected further away from the source areas. Based on the chemical properties of TCE, cis-1,2-DCE, and vinyl chloride and an average sitewide velocity, these CVOCs are estimated to travel at an average rate between about 40 and 60 feet/year, assuming no degradation of the CVOCs.

The groundwater data collected indicate that the chlorinated “parent compound” in groundwater (TCE) is being degraded by anaerobic dechlorination to transformation products (cis-1,2-DCE and vinyl chloride). Additionally, final and nontoxic degradation byproducts, ethane and ethene, were also detected at the site. Other natural attenuation data (geochemical and biochemical parameters) provide further evidence that the CVOCs are degrading in groundwater. Reductions in total CVOCs in groundwater, increases in daughter products, and trends in site conditions indicate that degradation is occurring. Continued natural attenuation monitoring is recommended to confirm trends in natural attenuation data and to evaluate seasonal variability as part of the evaluation of monitored natural attenuation (MNA) as a potential remedial approach.

## 1.7 Human Health Risk Assessment

A human health risk assessment (HHRA) was prepared using conservative assumptions and feasible exposure pathways that were based on current site conditions and both current and potential future site use. Use of these conservative assumptions (consistent with a reasonable maximum exposure scenario) was intended to overstate rather than understate the potential risks. The HHRA was performed initially using a risk screening analysis with risk-based concentrations obtained from the State of Illinois Tiered Approach to Cleanup Objectives (TACO) program. In addition to this streamlined screening approach, an

exposure assessment and toxicity assessment were performed. These assessments were used to evaluate potential exposure pathways and receptors not addressed by TACO values, and to develop cumulative risk estimates for comparison with USEPA target risk reduction goals. The results from comparison with the TACO values indicated several chemicals of potential concern, principally PCBs and carcinogenic PAHs in soil, and CVOCs in groundwater.

The results from this screening and the exposure and toxicity assessments chemical indicate that, based on current soil and groundwater characterization data, the potential risks to human health were higher than USEPA target risk reduction objectives in different portions of the site. The estimated risks are based on the assumption that remedial actions are not conducted to address these concentrations. These estimated risks are also based on the assumption that the site is redeveloped for future residential and recreational uses.

Chemicals in soil driving potential risks within the footprint of the OMC Plant 2 building principally are PCBs and carcinogenic PAHs. Chemicals in groundwater driving potential risks are CVOCs, including TCE and vinyl chloride. PCBs in soil within proposed future recreational areas to the north and east of the OMC Plant 2 building potentially drive human health risks in those areas. Under current conditions, there are no potentially complete exposure pathways with the exception of trespassers entering the OMC Plant 2 building. Potential contact with PCBs in building materials by these individuals is unlikely to represent human health risks higher than USEPA target risk reduction objectives.

## **1.8 Ecological Risk Assessment**

The ecological risk assessment (ERA) evaluated whether contaminants present at the site and surrounding areas represent a potential risk to exposed ecological receptors. The spatial extent of the ERA encompassed both onsite and offsite terrestrial habitat that currently exists or may be created as part of future development at the site. The ERA evaluated potential risks to terrestrial plant communities, threatened and endangered plant species, soil invertebrate communities, reptiles, birds, and mammals. Risks to receptors in aquatic habitat in the offsite dunes area, Lake Michigan, and Waukegan Harbor were not considered in the ERA. The methods and approaches used in this ERA were developed from applicable USEPA guidance for Region 5.

Based on the evaluation using conservative and more realistic exposure assumptions, potential risks from PCBs to ecological receptors currently exist in an isolated area in the offsite dunes area, and after future development in areas of created habitat with high concentrations of semi-volatile organic compounds (SVOCs) and PCBs. In the offsite dunes area, an evaluation of the spatial distribution of PCBs in surface soil indicates a limited area associated with potential risks to soil flora, including threatened and endangered plant species, soil fauna, and small insectivorous mammals. However, following USEPA's proposed removal activities, risks to these receptors are considered acceptable, and no further investigation is required.

After future development, there are potential risks from SVOCs and PCBs to soil flora, including colonizing threatened and endangered plant species, soil fauna, and small mammalian insectivores if suitable habitat is created and the existing soil concentrations are reflective of post-development conditions. Potential onsite risks to ecological receptors after

development can be minimized by several methods, including creating habitat in areas without elevated concentrations and by creating habitat on clean soil cover. However, because it is expected that the site will be significantly altered during the redevelopment, post-demolition conditions should first be characterized and soil removal should be considered for any “hot spots” that remain.

## Development and Identification of ARARs, RAOs, and PRGs

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### 2.1 Summary of Applicable or Relevant and Appropriate Requirements

Remedial actions must be protective of public health and the environment. Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

Definitions of the ARARs and the “to be considered” (TBC) criteria are given below:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not “applicable,” address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing a remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include IEPA TACO Tier 1 remediation objectives, USEPA drinking water health advisories, reference doses, and cancer slope factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. “Onsite” CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the NCP, 40 CFR 300.5, definitions of ARARs and as discussed in 55 Federal Register (FR) 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (e.g., fees, permitting, inspection, reporting

requirements) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Included in Appendix A are the chemical-specific, action-specific, and location-specific ARARs for the OMC Plant 2 site. The most important ARARs are discussed below. All potential ARARs are listed in Appendix A along with an analysis of the ARAR status relative to remediation of the OMC Plant 2 site.

### **2.1.1 Chemical-specific ARARs**

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the OMC Plant 2 site can be classified into three categories: (1) residual concentrations of compounds that can remain at the site without presenting a threat to human health and the environment; (2) land disposal restriction (LDR) concentrations that must be achieved if the contaminated media that either is a characteristic hazardous waste or contains a listed hazardous waste is excavated or extracted and later land disposed; and (3) effluent concentrations that must be achieved in treatment of groundwater for discharge to surface water or discharge to a publicly owned treatment works (POTW).

#### **Residual Concentrations**

There are no chemical-specific federal or Illinois ARARs for soils. TBCs for residual soil concentrations include the USEPA Region 9 PRGs and IEPA TACO remediation objectives. IEPA TACO remediation objectives are not ARARs because a facility may choose not to use them per 35 Illinois Administrative Code (IAC) 742.105 (a) and (b). These are discussed in detail in Section 2.3.

For groundwater, Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and the Illinois Water Quality Standards (IWQS; IAC Part 620) are ARARs. Illinois TACO remediation objectives are not ARARs but are similar to the IWQS.

#### **Land Disposal Restriction Concentrations**

The Resource Conservation and Recovery Act (RCRA) LDRs would apply to remedial actions performed at the OMC Plant 2 site if waste generated by the remedial action (e.g., contaminated soil) contains a RCRA hazardous waste or is itself a characteristic hazardous waste. Listed hazardous wastes are not known to have been disposed at the OMC Plant 2 site. As a result, excavated soils would not be required to be managed as listed hazardous wastes. If excavated and removed from the area of contamination (i.e., where the soil is "generated"), the soil may be a characteristic hazardous waste, such as a D040 toxicity characteristic hazardous waste for TCE (toxicity characteristic leaching procedure [TCLP] greater than 0.5 milligrams per liter [mg/L]).

Soil below the building slab has the greatest potential to be a characteristic hazardous waste, since TCE was widely used at the facility and it is a major groundwater contaminant. Extensive soil sampling below the slab was not conducted because of the relatively thin unsaturated zone and the difficulty in sampling below the concrete slab.

Generated soils that exceed the TCLP limit must be managed as a hazardous waste and must meet the LDR treatment standards for contaminated soil (40 CFR 268.49). The treatment standard for contaminated soil is the higher of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards (UTS). Treatment is required for the constituent (such as TCE) for which the soil is a characteristic hazardous waste as well as other "underlying hazardous constituents." Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (USEPA, 1998).

Table 2-1 presents the UTS and the 10 times the UTS and the maximum measured concentration in soil for each contaminant of concern (COC) at the OMC Plant 2 site. Based on the comparison of maximum measured concentration and 10 times the UTS, it appears that for soil that is a characteristic hazardous waste, treatment may be necessary for benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, PCBs, and TCE. In each case, however, most soil samples did not exceed 10 times the UTS. As a result, it is likely that only a minor portion of characteristic hazardous waste soil would require treatment prior to land disposal.

**TABLE 2-1**  
Universal Treatment Standards (UTS) for Contaminated Soil  
OMC Plant 2 FS

Chemical of Concern	UTS	10 x UTS	Maximum Soil Concentration	Potential for Soil to Require Treatment to Meet LDRs for Contaminated Soil
	mg/kg	mg/kg	mg/kg	Yes or No
Benzo(a)anthracene	3.4	34	47	Yes
Benzo(a)pyrene	3.4	34	40	Yes
Benzo(b)fluoranthene	6.8	68	51	No
Benzo(g,h,i)perylene	1.8	18	32	Yes
Benzo(k)fluoranthene	6.8	68	29	No
Dibenz(a,h)anthracene	8.2	82	13	No
Indeno(1,2,3,-c,d)pyrene	3.4	34	27	No
PCBs (sum of all isomers)	10	100	790	Yes
Trichloroethylene <sup>a</sup>	6	60	1,300	Yes
Vinyl chloride <sup>a</sup>	6	60	0.19	No

**Chemical of Concern without Universal Treatment Standards**

Dibenzofuran

<sup>a</sup>Chemical of concern only for groundwater. Included here because of potential to exceed TCLP limit  
TCE TCLP limit = 0.5 mg/L and VC TCLP limit = 0.2 mg/L.

## **2.1.2 Action-specific ARARs**

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important action-specific ARARs that may affect the RAOs and the development of remedial action alternatives are CERCLA, TSCA, and RCRA regulations.

### **Comprehensive Environmental Response, Compensation, and Liability Act**

CERCLA requires the selected remedy to meet the substantive requirements of all environmental rules and regulations that are ARARs unless a specific waiver of the requirement is granted. Waiver of ARARs may be requested (per NCP 300.430(f)(1)(ii)(C)) based on any one of six circumstances. It is not anticipated that any ARAR waivers under CERCLA will be necessary.

### **Toxic Substances Control Act**

TSCA regulates the remediation of soils contaminated with PCBs under 40 CFR 761.61. If excavated for disposal it requires soil contaminated with PCBs at concentrations of 50 mg/kg or greater to be disposed of at either a hazardous waste landfill permitted under RCRA or at a chemical waste landfill permitted under TSCA. TSCA also has specific requirements for PCB cleanup levels for porous and nonporous surfaces that are intended for reclamation or disposal. These are ARARs for building demolition wastes.

The self-implementing requirements for onsite cleanup of PCB remediation waste under 40 CFR 761.61 are not ARARs for CERCLA sites but are considered TBCs. Remediation of soils to 1 mg/kg total PCB is the cleanup level for high occupancy areas under TSCA and is generally used for CERCLA remediation of soils.

### **Resource Conservation and Recovery Act**

RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside the area of contamination. Such alternatives could include excavation of materials (e.g., soil). Requirements include waste accumulation, record keeping, container storage, disposal, manifesting, transportation, and disposal.

As discussed above, portions of the soil at the OMC Plant 2 site may be characteristic hazardous waste. If the soil is characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal. This includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a). The most likely LDR that would have to be met is the characteristic hazardous waste soil would have to be treated to 60 mg/kg TCE or 100 mg/kg PCB prior to disposal in a RCRA Subtitle C landfill. If the soil has no other underlying hazardous constituents, it could be treated to below the TCLP limit, rendering it nonhazardous and disposed in a Subtitle D landfill. Nonhazardous waste soil would be disposed in accordance with RCRA solid waste disposal requirements.

### 2.1.3 Location Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. The most important location-specific ARARs for the OMC Plant 2 site are the following:

- **Fish and Wildlife Coordination Act**—Enacted to protect fish and wildlife when actions result in the control or structural modification of a natural stream or body of water. The statute requires that any action takes into consideration the effect that water-related projects would have on fish and wildlife, and then take action to prevent loss or damage to these resources.
- **Endangered Species Act of 1973**—Requires that federal agencies insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat. In the future redevelopment scenario, potential risks to threatened and endangered plant species that may colonize created habitat are present. Risks are a result of the current concentrations of SVOCs and PAHs in soil.
- **Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands), 50 CFR § 6 Appendix A**—These are TBCs. They set forth USEPA policy for carrying out the provisions of Executive Orders (EOs) 11988 and 11990. EO 11988 requires that actions be taken to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. EO 11990 requires that actions at the site be conducted in ways that minimize the destruction, loss, or degradation of wetlands. Small wetland areas are present along the north and south ditches between the OMC site and Lake Michigan.

## 2.2 Remedial Action Objectives

The USEPA Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (USEPA, 1988a) and the NCP define RAOs as medium-specific or site-specific goals for protecting human health and the environment that are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. PRGs are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. These PRGs are developed and used in the FS, and they will be finalized in the Record of Decision (ROD) for the OMC Plant 2 site.

In this section, RAOs are developed for the media of concern at the OMC Plant 2 site. The media of concern include the OMC building, soil, sediment, and groundwater.

### 2.2.1 RAOs for OMC Building

There is a potential for unacceptable risks resulting from exposure to building surfaces by trespassers. The COCs are PCBs, and the excess lifetime cancer risk (ELCR) to trespassers is

estimated to be  $2 \times 10^{-4}$ . The RAO is to develop alternatives that will mitigate these risks to trespassers.

In addition, redevelopment of the site will require removal of portions of the building to be able to access contaminated soil below it as well as construct new residential or commercial buildings and infrastructure. The presence of the building has not allowed full characterization of the unsaturated zone soils below the concrete slab. Since the volume of soil below the slab requiring remediation is uncertain and will be known only after the slab has been removed, remediation of shallow soil below the floor slab is included as part of building remediation. In addition, soils immediately surrounding the building will also be included as part of building remediation. This soil may require remediation either as a result of unacceptable direct contact risk or because it may be a source of contamination to groundwater. Consequently, an additional objective for remediating this contaminated soil is to allow the goals for groundwater remediation to be met. The soil media discussed later addresses the remainder of soils outside the footprint of the building.

The RAOs for the OMC Plant 2 Building include the following:

- Prevention of trespasser human exposure to PCBs, through contact, ingestion, or inhalation on building surfaces that present an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .
- Removal building and concrete slab as necessary to allow site remediation.
- Prevention of residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents a hazard index (HI) greater than 1 or an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .
- Remediation of contaminated soils below the building slab, as necessary, to prevent leaching of contaminants to groundwater that result in groundwater in excess of MCLs, IWQS for Class I groundwater, or for contaminants without primary SDWA MCLs, the HI is greater than 1 or the ELCR is greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .

### **2.2.2 RAOs for Soil**

There is a potential for unacceptable risks from exposure to onsite soil by future residents and construction workers and of exposure to the offsite area east of the site by recreational users. The risk assessment calculated an ELCR of  $2 \times 10^{-4}$  for residential exposure to onsite soil and an ELCR of  $1 \times 10^{-5}$  for construction worker exposure to onsite soil. The risk assessment estimated a HI of 4.9 and an ELCR of  $1.5 \times 10^{-4}$  for adolescents for the offsite soil east of the site as a result of PCBs. USEPA has remediated a portion of this soil through a removal action.

The ERA found potential risks to ecological receptors in an isolated area in the dunes east of the site. The USEPA removal action of PCB soils exceeding 10 mg/kg, though, will alleviate these potential risks, and therefore, additional remediation is not needed for ecological risks. The ERA also found that in a future site development scenario, created habitats in areas of high SVOCs and PCBs could result in potential ecological risks. The area of elevated SVOCs and PCBs in soil coincides with the areas presenting unacceptable risks to human health. As

a result, RAOs and PRGs specific to protection of ecological receptors from exposure to soil contaminants are not needed.

The RAOs for onsite soil at the OMC Plant 2 site include the following:

- Prevention of residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$
- Prevention of erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ )

The RAOs for offsite soil east of the site include the following:

- Prevention of recreational human user exposure, through contact, ingestion, or inhalation to contaminated soil that presents an HI greater than 1 or an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  for PCBs
- Prevention of erosion and transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ )

### 2.2.3 RAOs for Sediment

Investigations conducted prior to the RI found the sediments from the North and South ditches to have elevated concentrations of PCBs, exceeding the 1 mg/kg PCB cleanup level typically used for sediment. As a result, further sediment investigations conducted during the RI focused on identifying the volume of sediment contained in these ditches. The RAO for the sediment is as follows:

- Remediation of sediment in the North and South Ditches exceeding a PCB cleanup level of 1 mg/kg

### 2.2.4 RAOs for Groundwater and DNAPL

There is a potential for unacceptable risk from residential indoor inhalation of vapors from groundwater onsite. The risk assessment calculated an ELCR of  $6 \times 10^{-4}$  for this exposure pathway. Also, there is a potential unacceptable risk from construction worker exposure to groundwater. The risk assessment estimated an ELCR of  $6 \times 10^{-4}$  and the HI of 7.

Although there are no current groundwater receptors at the OMC Plant 2 site, RAOs for groundwater were developed to minimize further migration of the contaminant plume and limit the time needed to remediate groundwater to below unacceptable risk levels.

Groundwater within the DNAPL area onsite may not be able to be remediated to ARARs within a reasonable time, so the RAO was modified for this area.

The RAOs for remediation of groundwater at the OMC Plant 2 site include the following:

- Prevention of residential indoor inhalation of VOCs that presents an HI greater than 1 or an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .

- Prevention of construction worker exposure to groundwater, through contact, ingestion, or inhalation that presents an HI greater than 1 or an ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .
- Remediate contamination in groundwater to concentrations below MCLs and IWQS for Class I groundwater, or for contaminants without primary SDWA MCLs, an HI greater than 1 or ELCR greater than  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  within a reasonable time frame.
- Remediate DNAPL and groundwater within the DNAPL area to the extent practicable and minimize further migration of contaminants in groundwater.

## 2.3 Preliminary Remediation Goals

To meet the RAOs defined in Section 2.2, PRGs were developed to define the extent of contaminated media requiring remedial action. This section presents the PRGs and defines the volumes of affected media exceeding the PRGs that will be addressed in the FS process. In general, PRGs establish media-specific concentrations of COCs that will pose no unacceptable risk to human health and the environment. COCs are the list of chemicals that result in unacceptable risk based on the results of the risk assessment. The PRGs are developed considering the following:

- Risk-based concentration levels corresponding to an ELCR between  $1 \times 10^{-4}$  and  $1 \times 10^{-6}$ , a chronic health risk defined by an HI of 1, and/or a significant ecological risk. As discussed earlier, PRGs for ecological receptors are not needed at the OMC site because the areas presenting potential risk either have been remediated under the USEPA removal action or coincide with the areas presenting unacceptable human risk.
- Chemical-specific ARARs/TBCs including federal MCLs for groundwater, IWQS for Class 1 groundwater, and IEPA TACO Tier 1 remedial objectives for soil and groundwater. The TACO Tier 1 remediation objectives are TBCs and are set at the HI equals 1 and ELCR values at  $1 \times 10^{-6}$ . The ELCR values could be modified upward to represent the values corresponding to a cumulative risk of  $1 \times 10^{-4}$ .
- Background concentrations of specific constituents.

A summary of the PRGs for soil and groundwater exposure pathways at the OMC Plant 2 site are included in Tables 2-2 and 2-3, respectively. PRGs for the OMC building are not listed separately in the tables. Building surfaces such as walls, floors, and piping must be remediated in accordance with TSCA regulations. These regulations and action levels are presented in Appendix A.

**TABLE 2-2**  
Soil PRGs  
OMC Plant 2 FS

Chemical	Soil PRGs					
	Soil Background <sup>a</sup> (mg/kg)	USEPA Region 9 Risk- Based Concentrations (mg/kg)	Tier 1 TACO Residential Soil Value (mg/kg)		Tier 1 TACO Construction Worker Soil Value	
			Ingestion	Inhalation	Ingestion	Inhalation
Volatile Organic Compounds (VOCs)						
Trichloroethylene <sup>b</sup>	-	0.053	58	5	1200	12
Semi-volatile Organic Compounds (SVOCs)						
Benzo(a)anthracene	1.8	0.62	0.9	NA	NC	NC
Benzo(a)pyrene	2.1	0.062	0.09	NA	17	NA
Benzo(b)fluoranthene	2.0	0.62	0.9	NA	NC	NC
Benzo(g,h,i)perylene	NA	NA	NA	NA	NC	NC
Benzo(k)fluoranthene	1.7	6.20	9	NA	NC	NC
Dibenz(a,h)anthracene	0.42	0.062	0.09	NA	NC	NC
Dibenzofuran	NA	NA	NA	NA	NC	NC
Indeno(1,2,3-c,d)pyrene	1.6	0.62	0.9	NA	NC	NC
Naphthalene	NC	56	NC	NC	4100	1.8
PCBs <sup>c</sup>						
PCB-1248 (Arochlor 1248)		0.22	1	NA	NC	NC
PCB-1254 (Arochlor 1254)		0.22	1	NA	1	NA
PCB-1260 (Arochlor 1260)	-	0.22	1	NA	1	NA

**TABLE 2-2**  
Soil PRGs  
*OMC Plant 2 FS*

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Notes:

<sup>a</sup> PAH soil background values approved by IEPA based on results of the Electric Power Research Institute (EPRI; *Final report on Background PAHs in Surface Soil in Illinois*).

Values are the lognormal 95th percentile for urban areas within a metropolitan statistical area having a population density of at least 1,000 people / square mile and a minimum population of 10,000.

Selected Soil PRG highlighted in bold with shaded background. Where the background value is higher than the lowest PRG, the background value is used as the PRG.

<sup>b</sup> TCE was a COC only for the construction worker exposure route in the risk assessment. As a result the construction worker PRG applies to subsurface soil. However if TCE is detected in surface soil it is compared against the residential PRG.

<sup>c</sup> The PCB PRG is 1 mg/kg based on the US EPA TSCA cleanup levels (40 CFR 761.61).

NC- Not a chemical of concern

NA = Not available or not applicable.

TACO - Tier 1 Soil Remediation Objectives for Residential Properties - Appendix B, Table A (IEPA, 2001).

TACO - Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties -Appendix B, Table B (IEPA, 2001).

**TABLE 2-3**  
Groundwater PRGs  
OMC Plant 2 FS

Chemical	Groundwater PRGs			
	Federal SDWA MCL (mg/L)	Illinois Water Quality Standard- Groundwater Class I (mg/L)	Illinois Tier 1 TACO Groundwater Criteria Class I (mg/L)	Groundwater Volatilization to Indoor Air (mg/l)
<b>Volatile Organic Compounds (VOCs)</b>				
Chloroform	0.0800	NA	0.0002	NC
cis-1,2-Dichloroethylene	0.070	0.070	0.070	NC
trans-1,2-Dichloroethene	0.100	0.100	0.100	NC
Trichloroethylene	0.005	0.005	0.005	0.0065
Vinyl chloride	0.002	0.002	0.002	0.0003
<b>Pesticides/PCBs</b>				
PCB-1016 (Arochlor 1016)	0.0005	0.0005	0.0005	NA
PCB-1248 (Arochlor 1248)	0.0005	0.0005	0.0005	NA
<b>Metals</b>				
Arsenic (Total) <sup>a</sup>	0.010	0.050	0.050	NA
Manganese (Total)	NA	0.150	0.150	NA

Notes:

Selected PRG highlighted in bold with shaded background.

<sup>a</sup> Arsenic MCL of 0.01 mg/l was promulgated in 2001 and went into effect on January 23, 2006.

NC- Not a chemical of concern

NA = Not available or not applicable.

TACO - Tier 1 Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route - Appendix B, Table E (IEPA, 2001).

### 2.3.1 PRGs for Soil

Based on the potential future exposure risks and the RAOs presented in Section 2.2.2, soil PRGs were developed for surface and subsurface soil, depending on residential or construction worker exposure. PRGs were not developed at this time to address the RAO to prevent leaching of soil contaminants to groundwater. This is because leaching is not a pathway of concern outside the building footprint. Within the building footprint, sufficient data are not available to evaluate this pathway or identify the COCs. Once the building slab is removed, additional sampling and analysis will be performed, and site-specific PRGs to address leaching will be developed at that time.

Soil PRGs for each of the site COCs and for each of the above pathways are presented in Table 2-2. Soil PRGs developed for residential protection from direct contact ingestion and inhalation exposures are based on USEPA Region 9 PRGs and are protective at a risk level of HI of 1 and ELCR of  $1 \times 10^{-6}$ . These PRGs were applied to shallow soils (less than 2 feet deep). PRGs developed for construction worker protection from direct contact ingestion and

inhalation exposures were applied to all unsaturated zone soil (less than 5 to 8 feet deep). Where there was little difference in soil volumes exceeding the residential versus construction PRGs, the more conservative residential PRGs were used. This occurs for soils contaminated with carcinogenic PAHs and PCBs below 2 feet.

PAH PRGs also include soil background values because PAHs are found to be ubiquitous in urban environments. The PAH background values are those developed jointly by IEPA and the Electric Power Research Institute (EPRI) in the Final Report on Background PAHs in Surface Soil in Illinois. The background PAH values are presented on the IEPA Bureau of Land Web site: <http://www.epa.state.il.us/land/index.html>.

### **2.3.2 PRGs for Sediment**

ARARs for sediment PCB remediation cleanup levels are not available. The PCB PRG for sediment is 1 mg/kg based on USEPA policy for sediment remediation.

### **2.3.3 PRGs for Groundwater**

PRGs were developed for groundwater based on the RAOs discussed earlier. The SDWA federal MCLs, IWQS, and Illinois TACO Tier 1 values were compared to develop the groundwater PRGs. In general, the three sources of PRGs have either the same or similar values.

PRGs were also developed to address the RAO for volatilization of groundwater VOCs to indoor air. These values apply to TCE and vinyl chloride and are based on an ELCR of  $1 \times 10^{-6}$ . They were developed using the Johnson and Ettinger (1991) Model and their development is documented in Appendix A.

## **2.4 Contaminated Media Exceeding PRGs**

The areas and depths of soil and groundwater that exceed the PRGs were developed by comparing results with the lowest applicable PRG. Below is a discussion of the media exceeding the PRGs.

### **2.4.1 OMC Building**

The areas of the OMC building having PCBs on surfaces that present unacceptable health risks or exceed the  $10 \mu\text{g}/100 \text{ cm}^2$  TSCA criteria are shown in Figure 2-1. These areas generally coincide with the areas of the building either known or suspected to have soil contamination.

### **2.4.2 Soil**

The soil areas outside the building footprint with COC concentrations exceeding the PRGs for PCB and PAHs are shown in Figures 2-2 through 2-5. The estimated in situ volume of soil onsite exceeding the PRGs is 30,460 cubic yards. The majority of this is limited to the upper 2 feet. The residential PRGs were also applied to soil below 2 feet because of the potential for mixing of these soils with surface soils during site development and because of the limited amount of soil contamination below 2 feet outside the building footprint.

The estimated volume of soil exceeding the PRGs in the dune area east of the site is 6,140 cubic yards. This is in addition to the volume previously excavated and stockpiled onsite as part of the USEPA removal action.

### **2.4.3 Sediment**

*The entire length of the North and South ditches exceed the PCB PRG of 1 mg/kg. The estimated in situ sediment volumes are 3,500 cubic yards and 730 cubic yards for the North and South ditches, respectively.*

### **2.4.4 Groundwater**

The area exceeding all groundwater PRGs is defined by the area exceeding the TCE PRG of 5 micrograms per liter ( $\mu\text{g/L}$ ; Figure 2-7). The area of groundwater is estimated to be 15.25 acres. The full saturated thickness of the sand aquifer is contaminated above PRGs in this area. The volume of groundwater exceeding PRGs is estimated at 44.7 million gallons, assuming an average saturated thickness of 30 feet and a porosity of 30 percent.

## Identification and Screening of Technologies

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After the RAOs and PRGs were developed, general response actions consistent with these objectives were identified; general response actions are basic actions that might be undertaken to remediate a site (e.g., no action, in situ treatment, or excavation and treatment). For each general response action, several possible remedial technologies may exist. They can be further broken down into a number of process options. These technologies and process options are then screened based on several criteria. Those technologies and process options remaining after screening are assembled into alternatives in Section 4.

*The following sections present general response actions for each media that may be applicable to OMC Plant 2. The soil and sediment media were combined because the media present similar characteristics in depth and degree of contamination. Likewise, technology screening for DNAPL was combined with groundwater because of the limited DNAPL extent and the similarities in technologies addressing high concentration source area groundwater and DNAPL. Technologies suited to just DNAPL are identified and discussed separately.*

### 3.1 General Response Actions for Building

The general response actions for the building at OMC include the following:

- No further action
- Institutional controls
- Containment
- Removal/treatment/disposal

Each general response action is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

#### 3.1.1 No Further Action

The no further action response includes no action for the building except for what has already been implemented (i.e., OMC and USEPA removal actions in 2002). The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

#### 3.1.2 Institutional Controls

Institutional controls for the building consist of restricting access to the property through fencing or land use restrictions. At OMC, these measures would be used primarily for limiting human contact with the building materials.

### **3.1.3 Containment**

Containment is used to minimize the risk of contaminant migration as well as prevent direct contact exposures. Consolidation and capping onsite are applicable technologies for the building materials.

### **3.1.4 Removal/Treatment/Disposal**

Physical, chemical, or thermal technologies are used once the building is demolished. Physical processes include transferring the building materials to an approved onsite or offsite disposal area. Biological processes are not applicable. Chemical processes such as washing/flushing or thermal processes such as incineration to treat the material will also be evaluated. Treatment residue would be disposed of onsite if it no longer contained COC concentrations posing a risk to human health or the environment; otherwise disposal in a licensed, permitted disposal facility would be necessary.

## **3.2 General Response Actions for Soil and Sediment**

The general response actions for soil and sediment at OMC include the following:

- No further action
- Institutional controls
- Containment
- In situ treatment
- Excavation/treatment/disposal

Each general response action is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

### **3.2.1 No Further Action**

The no further action response includes no action for soil except for what has already been implemented (i.e., construction of the East and West Containment Cells). The no further action response would not satisfy the RAO of preventing exposure to COCs. Therefore, this action may not be feasible for OMC. The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

### **3.2.2 Institutional Controls**

Institutional controls for soil and sediment consist of restricting access to contaminated soil and sediment through fencing or land use restrictions. At OMC, land use restrictions would be used primarily for limiting human contact with the contaminated soil and sediment.

### **3.2.3 Containment**

Containment is used to minimize the risk of contaminant migration as well as prevent direct contact exposures. Surface controls such as grading and revegetating can be used to reduce infiltration of precipitation through contaminated soil and prevent further erosion and offsite transport of contaminated soil. Capping and subsurface barriers are two applicable remedial technologies that could also be used at OMC to limit exposure to contaminants,

help prevent contaminant migration, and limit the infiltration of precipitation. In situ containment of sediment is not considered because of the potential for future erosion and the relatively limited extent.

### **3.2.4 In Situ Treatment**

In situ treatment methods can be used to reduce the contaminant concentrations in soil. In situ methods that may be applicable to soil at OMC include primarily biological technologies, such as land treatment or in situ soil mixing. A wide variety of technologies are considered in screening, including soil vapor extraction (SVE), bioventing, and surfactant flushing. However, the relatively shallow location of contaminants, the type of contaminants, and high water table at OMC significantly reduce the number of viable in situ treatments. In situ technologies for sediment are limited because they are either too difficult to apply or are more destructive of the ecosystem (e.g., in situ solidification) than protective.

### **3.2.5 Excavation/Treatment/Disposal**

Physical, chemical, biological, or thermal technologies are used once soil or sediment is excavated. Physical processes include excavating the contaminated soil and sediment and transferring it to an approved onsite or offsite disposal area. Biological processes such as land farming will be evaluated. Chemical processes such as washing/flushing or thermal processes such as incineration to treat the soil to meet soil disposal criteria will also be evaluated. Treatment residue would be disposed of onsite if it no longer contained COC concentrations posing a risk to human health or the environment; otherwise, disposal in a licensed, permitted disposal facility would be necessary.

## **3.3 General Response Actions for Groundwater and DNAPL**

The general response actions for groundwater at the OMC site include the following:

- No further action
- Institutional controls
- Containment
- In situ treatment
- Collection/treatment/discharge

Groundwater includes both the complete plume exceeding PRGs as well as several higher concentration source areas within the plume. DNAPL includes both the free-phase “pool” as measured as a separate phase during the RI and residual DNAPL, which is present in soils but by definition does not flow and is not extractable by pumping.

### **3.3.1 No Further Action**

The no further action response includes no action for groundwater.

### **3.3.2 Institutional controls**

Institutional controls such as access restrictions or a restrictive covenant on the property deed of the OMC site limiting intrusive activities on the property may be necessary either as a standalone action or in concert with other actions. Groundwater and surface water

monitoring may also be necessary to track the direction and rate of movement of the groundwater contaminant plume as well as to track changes in DNAPL thickness and whether the DNAPL is migrating.

### **3.3.3 Containment**

Containment refers to minimizing the spread of groundwater contaminants through active or passive hydraulic gradient controls. Active gradient control can be accomplished with pumping wells, while passive gradient control can be achieved using a slurry or sheet-pile wall. Containment of groundwater can be effective in preventing the release of contaminants from the source areas and their subsequent migration.

Containment of DNAPL may be through active or passive hydraulic gradient controls. Active gradient control can be accomplished with injection wells or trenches, while passive gradient control can be achieved using a slurry or sheet pile wall.

### **3.3.4 In Situ Treatment**

In situ treatment of groundwater entails treating the groundwater while it is in the aquifer, which can be achieved by applying physical/chemical, biological, or thermal techniques. Examples of possible approaches to in situ treatment of CVOCs in groundwater include chemical oxidation, MNA, chemical reduction, permeable treatment beds, resistive heating, thermal desorption, and/or biological treatment technologies. In situ treatment can be directed at the high concentration source areas or throughout the plume.

DNAPL would be treated in situ with surfactant or solvent washing/flushing, thermal treatment, soil mixing, in situ chemical oxidation, or in situ chemical reduction.

### **3.3.5 Collection/Treatment/Discharge**

In this response action, groundwater would be extracted from the aquifer using pumping wells. The contaminants would then be removed from the water by physical, physical/chemical, chemical, or biological treatment. Disposal of groundwater can be accomplished by surface infiltration, subsurface injection, discharge to the POTW, or discharge to surface water.

DNAPL would be extracted from the subsurface using wells. Enhancements for DNAPL extraction such as use of surfactants or cosolvents are also possible. The collected DNAPL would then be disposed of offsite.

## **3.4 Identification and Screening of Technology Types and Process Options**

In this section, the technology types and process options available for remediation of building materials, soil, sediment, DNAPL, and groundwater are presented and screened. An inventory of technology types and process options is presented based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified in Sections 3.1, 3.2, and 3.3. Each technology type and

process option is either a demonstrated, proven process, or a potential process that has undergone laboratory trials or bench-scale testing.

Each technology and process option is screened based on a qualitative comparison of effectiveness, implementability, and relative cost. This step may eliminate a general response action from the alternatives screening process if there are no feasible technologies identified. The objective, however, is to retain the best technology types and process options within each general response action and use them for developing remedial alternatives. The evaluation and screening of technology types and process options are presented in Tables 3-1 through 3-3 for building materials, soil/sediment, and groundwater/DNAPL, respectively. Those technologies and process options that are screened out based on effectiveness, implementability, and/or cost are highlighted in the tables.

As mentioned above, technology types and process options are screened in an evaluation process based on effectiveness, implementability, and relative cost. Effectiveness is considered the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present at the site. Additionally, the NCP defines effectiveness as the "degree to which an alternative reduces TMV through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed by the OMC site. At this point, the cost criterion is comparative only, and similar to the effectiveness criterion, it is used to preclude further evaluation of process options that are very costly if there are other choices that perform similar functions with similar effectiveness. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

The NCP preference is for solutions that utilize treatment technologies to permanently reduce the TMV of hazardous substances. Available treatment processes are typically divided into three technology types: physical/chemical, biological, and thermal, which are applied in one or more general response actions with varying results.

The technology types and process options remaining following screening and identified in the following sections are subject to refinement/revision based on further investigation findings, results of treatability studies, or recent technological developments.

### **3.4.1 Technology and Process Option Screening for the Building Materials**

Table 3-1 presents a range of potentially applicable technology types and options for addressing the buildings at the site. The screening is intended to highlight the most important aspects of the technology relative to the screening criteria. The last column titled "Screening Comments" provides a summary of the rationale for rejection of a technology or process option.

**TABLE 3-1**  
Remedial Technology Screening – Building Materials  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
<b>No Action</b>						
None	None	No further actions to address impacted soils.	None	Implementable	Zero	Required for comparison.
<b>Institutional Controls</b>						
Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially impacted areas to restrict property use.	Good	Dependant on opposition from current owner or potential issue for future land owner	Low	Not retained. Area slated for potential future re-development as residential. ICs alone would result in building remaining and precluding future site development.
	Fences	Security fences installed around potentially impacted areas to limit access.	Good	Good	Low	Not retained. Fences presume the building remains, thus precluding future site development.
	Permits	Regulations promulgated to require a permit for excavation/removal activities.	Good	Good	Low	Not retained. Permits presume the building remains, thus precluding future site development.
<b>Containment</b>						
Capping of Building Slab In-Place	Native soil, clay cap, synthetic membranes, sealants, asphalt, concrete	Cap material placed over concrete slab of building once roof and walls are demolished and removed.	Cap integrity must not be compromised by present and future land use activities. Effective in preventing direct contact, erosion and leaching of contaminants from concrete slab.	A cap over the concrete slab would preclude future site development.	Caps are generally the least expensive way to manage the human health and ecological risks effectively.	Not retained. A cap is not compatible with future site development.

**TABLE 3-1**

Remedial Technology Screening – Building Materials

OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Capping of Rubbelized Building Slab	Native Soil, clay cap, synthetic membranes, sealants, asphalt, concrete	Cap material placed over demolished concrete slab that is consolidated onsite along north perimeter of property.	Cap integrity must not be compromised by present and future land use activities. Effective in preventing direct contact, erosion and leaching of contaminants from concrete slab.	A cap over the demolished concrete slab is compatible with future site development assuming it is placed in a berm along northern site boundary.	Caps are generally the least expensive way to manage the human health and ecological risks effectively.	Retained.
Surface Controls		Surface controls used to reroute surface water around contamination or otherwise control erosion.	Surface controls are generally not applicable to a raised concrete slab.	Surface controls with the concrete building slab remaining-would preclude future site development.	Low	Not retained. surface controls are not compatible with future site development.
<b>In Situ Treatment</b>						
		In situ treatments are designed to treat soils or groundwater in-place and are not applicable to buildings	Not applicable to buildings or contaminated concrete in-place.	Not applicable	Not applicable	Not applicable to an aboveground structure.
<b>Ex situ Treatment</b>						
Biological	Biopiles, composting, landfarming	There are a variety of ex situ biological treatment methods for organic contaminants in soil. However none are applicable to PCBs in cement.	Not applicable to buildings or contaminated concrete in-place.	Not applicable	Not applicable	Not applicable to an aboveground structure.

**TABLE 3-1**  
Remedial Technology Screening – Building Materials  
*OMC Plant 2 FS*

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical / Chemical	High pressure washing, solvent washing, scarifying, wiping	There are a variety of ex situ physical/chemical treatment methods for organic contaminants in soil. Most are not applicable to PCBs in cement. Methods to decontaminate PCBs from porous and nonporous surfaces include high pressure washes, solvent washes, physical wiping of metal surfaces, and scarifying concrete surfaces.	Generally can be effective in reducing PCB concentrations to below criteria that allow metal recycling, concrete re-use or disposal as a solid waste.	Implementable for surficial PCB contamination. Scarifying to remove PCBs impregnated throughout concrete may not be implementable.	Labor intensity generally results in high cost to remove PCBs. However it may be cost effective for metal recycling or to reduce high costs for offsite disposal in TSCA landfill.	Retained.
Thermal		Thermal treatments are not applicable to building materials other than metals intended for recycling in smelters. TSCA has specific requirements for PCB contaminated metals recycling and these requirements are ARARs.	Effective in destroying PCBs. Smelters have TSCA monitoring requirements to verify effectiveness.	Technology is commercially available.	Costs are high for metals heavily contaminated with PCBs.	Retained for further evaluation.
<b>Removal</b>						
Excavation	Excavation/Demolition	Demolition of building and concrete with ordinary construction equipment such as cranes, backhoes, bulldozers, and front-end loaders.	Effective in removing PCB contaminated material.	Technology is commercially available.	Relatively high cost for PCB contaminated structures	Retain for further evaluation.
<b>Disposal</b>						
Onsite Consolidation		Onsite consolidation of rubblelized concrete into a berm along north side of site.	Effective because of very limited mobility characteristics of PCBs.	Implementable though engineering characteristics of existing containment cells in area needs to be considered.	Low	Retain for further evaluation.

**TABLE 3-1**  
 Remedial Technology Screening – Building Materials  
 OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Landfill	TSCA Landfill	Solid wastes with PCBs > 50 mg/kg or 100 ug/100 cm <sup>2</sup> are permanently disposed of in a TSCA permitted landfill.		Technology is commercially available at a full scale for the COCs at OMC.		Retained for further evaluation.
	Non-RCRA Landfill	Solid nonhazardous wastes are permanently disposed of in a Subtitle D landfill.		Technology is commercially available at a full scale for the COCs at OMC.		Retained for further evaluation.

**Note:**

COC = Compounds of concern

BCD = Base-catalyzed dechlorination

Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.

Potentially feasible technologies and options for each general response action for addressing the buildings at the site are shown in plain text (i.e., background not shaded) in Table 3-1. The response actions and associated technologies retained following screening include the following:

- No further action
- Containment: capping of demolished building slab
- Removal and treatment: physical/chemical treatment and thermal treatment of metal
- Removal and disposal: onsite consolidation, offsite landfill

The rationale for selecting these process options is indicated in Table 3-1. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options.

### **3.4.2 Containment**

Under the containment response, capping was selected because it is a relatively inexpensive option and would effectively prevent direct contact exposure and erosion. The method excludes capping of the building slab in-place because this method is not compatible with future site development. However, capping of the demolished building slab was retained as an option because demolition prior to capping would provide for consolidation of the material in a location appropriate to future site development.

### **3.4.3 Treatment**

Physical/chemical treatment of porous and nonporous building materials would be conducted prior to demolition to remove PCBs to below regulatory concentrations to allow for less expensive disposal options. Demolition contractors familiar with PCB remediation would determine the cost-effectiveness of cleaning methods versus disposal costs. Building materials exceeding regulatory PCB criteria would be disposed offsite in a TSCA landfill. Metal could be recycled if it is not contaminated with PCBs or is decontaminated onsite. Contaminated metal can also be recycled in a smelter meeting TSCA requirements. This was also retained as a potentially viable technology.

The type of physical/chemical treatment would be determined either as part of design or would be determined by the demolition contractor. Onsite consolidation or offsite disposal in a Subtitle D landfill are viable technologies for concrete with PCBs less than 50 mg/kg. There are Subtitle D and TSCA landfills in Illinois and some adjoining states in relative proximity to the OMC site. Disposal was retained as an option because of the comparatively low cost and availability of disposal facilities. Recycling of concrete passing regulatory criteria is also potentially viable.

Thermal treatment of concrete with PCBs greater than 50 mg/kg was also considered. Thermal treatment uses heat to volatilize organic compounds and remove them. This technology is generally used with soil and would, therefore, require crushing the concrete material prior to treatment. This method would not be applicable to other building materials, such as structural steel, roofing, or siding. Additional pretreatment may be required to adjust the moisture content once concrete is crushed. Heat is applied through natural gas or other fuel combustion with direct heat transfer to the media in a rotary or asphalt kiln. (Indirect methods are less common.) Media is processed and fed to the thermal

treatment device and the treated recycled concrete is then stockpiled and eventually backfilled at the site.

High-temperature thermal desorption is capital intensive and requires multiples steps. In addition, air emission control would be necessary. The system air emission controls would include a cyclone particulate removal device for emissions exiting the kiln to protect the baghouse used for fines removal. Following the baghouse, the air emissions would be treated in a natural gas-fired incinerator (afterburner) to oxidize the desorbed organics. Air emission controls can add significant cost to the method because of the treatment required to remove dioxins and furans.

In incineration, high temperatures are used to volatilize and combust halogenated and other refractory organics (1,400 to 2,200 degrees Fahrenheit [°F]). Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is applicable to a wider range of material than thermal treatment in that it oxidizes bulk quantities of waste that may be in liquid and solid phase.

There are only three incinerators in the United States that hold a TSCA permit to incinerate PCB-contaminated materials. These facilities are located in Texas and Utah. Transportation of the contaminated media to these facilities would be required for offsite incineration, which would result in a relatively high transportation cost compared to other alternatives.

Thermal treatment or incineration may be cost competitive when compared to offsite disposal of material at a TSCA landfill. However, while thermal treatment may be applicable to crushed concrete, there is a relatively low volume of concrete that would be required for disposal at a TSCA landfill. This method was not retained for further consideration because of the resulting high overall relative cost compared to offsite disposal.

### **3.5 Technology and Process Option Screening for Soil and Sediment**

Table 3-2 presents a wide range of potentially applicable technology types and process options for soil and sediment remediation at the site. The screening is combined for soil and sediment because the media presents similar characteristics in depth and degree of contamination.

The response actions and associated technologies retained following screening including:

- No further action
- Institutional controls: deed restrictions and permits
- Excavation of the soil and sediment
- Removal and disposal: onsite consolidation, disposal offsite (TSCA or Subtitle D landfills)

The rationale for selecting these process options is indicated in Table 3-2. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These include evaluation of containment in-place and ex situ chemical treatment (chemical extraction, Sonoprocess™) or thermal treatment (high-temperature thermal desorption, incineration).

TABLE 3-2  
Remedial Technology Screening – Soil and Sediment  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
<b>No Action</b>						
None	None	No further actions to address soils exceeding PRGs.	None	Implementable	None	Required for comparison.
<b>Institutional Controls</b>						
Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially impacted areas to restrict property use.	Poor if used alone since exposures to surface soil are not controllable with restrictive covenants alone. Effective for controlling access to subsurface soil.	Implementable	Low	Retained for use only in conjunction with other technologies. Not retained as a sole technology because area is intended to be redeveloped as residential.
	Fences	Security fences installed around potentially impacted areas to limit access.	Good	Good	Low	Not retained. Fencing to prevent access is not compatible with future site development.
	Permits	Regulations promulgated to require a permit for excavation/removal activities.	Not applicable to surface soil contamination. May be effective in controlling subsurface excavation into contaminated soil and disposal of excavated contaminated soil.	May be difficult to implement for individual parcels.	Low	Retained. Permits for subsurface excavation could be used as a means to provide notification for potential subsurface contamination and proper disposal of contaminated subsurface soil.
<b>Containment</b>						
Capping	Native soil cover	Soil exceeding PRGs covered with uncontaminated native soil and revegetated to prevent direct contact and erosion. Control of leaching is not essential because PCBs and PAHs onsite in soil have limited mobility.	Effective if future site development does not result in placement of contaminated soil from below the cover.	Easily implemented.	Covers are generally the least expensive way to manage the human health and ecological risks effectively.	Not retained. A native soil cover may not be effective in the long-term in the dune area. Onsite the soil exceeding PRGs is relatively shallow and can be cost-effectively excavated eliminating the need for long-term management below a residential development.
	Clay cap, synthetic membranes, sealants, asphalt, concrete	Soil exceeding PRGs capped with any one of a variety of low permeability cap materials to prevent direct contact, erosion and leaching.	Effective if future site development does not result in excavation through the cap.	Easily implemented but precludes future site development because the integrity of the cap would be compromised by the subsurface building foundations and utilities.	Caps are generally a low cost method to manage the human health and ecological risks effectively.	Not retained. A cap over the soil exceeding PRGs would prevent future site development. Not retained for sediment because cap is subject to future erosion.
Surface Controls		Surface controls used to reroute surface water around contamination or otherwise control erosion.	Surface controls are generally not effective alone but must be used with covers or caps.	Easily implemented.	Low	Not retained. Surface controls alone are not compatible with future site development.
<b>In Situ Treatment</b>						
Biological	Enhanced Aerobic Bioremediation	Injection of water containing inducers and electron acceptor (oxygen) to enhance aerobic biodegradation. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass.	Bioremediation is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration. An infiltration gallery or spray irrigation is typically used for shallow impacted soils, and injection wells are used for deeper impacted soils.	Typical costs for enhanced bioremediation range from \$20 to \$80 per cubic yard of soil. Variables affecting the cost are the nature and depth of the COCs and use of bioaugmentation.	Not retained. Not well suited for contaminants of concern and concentrations in the soils which are found onsite.

**TABLE 3-2**  
Remedial Technology Screening – Soil and Sediment  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Enhanced Anaerobic Bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, dinitrogen gas is ultimately produced.	Bioremediation is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration. An infiltration gallery or spray irrigation is typically used for shallow impacted soils, and injection wells are used for deeper impacted soils.	Typical costs for enhanced bioremediation range from \$20 to \$80 per cubic yard of soil. Variables affecting the cost are the nature and depth of the COCs and use of bioaugmentation.	Not retained. Not well suited for contaminants of concern and concentrations in the soils which are found onsite.
	Bioventing	Oxygen is delivered to impacted unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. Bioventing uses low airflow rates to provide only enough oxygen to sustain microbial activity.	Bioventing is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration.	Moderate costs. Costs for operating a bioventing system typically are \$10 to \$50 per cubic yard. Factors that affect the cost of bioventing include contaminant type and concentration, soil permeability, well spacing and number, pumping rate, and off-gas treatment.	Not retained. Not well suited for contaminants of concern in the soil and hydrogeology which is found onsite.
	Natural Attenuation	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Generally, the lowest cost alternative were applicable.	Not retained. Not effective for PCBs.
	Land Treatment	Impacted surface soil is treated in place by tilling to achieve aeration, and if necessary, by addition of amendments. Periodically tilling, to aerate the waste, enhances the biological activity.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Moderate costs: \$25 to \$50 per cubic yard.	Not retained due to limited effectiveness on PCBs.
	In-Situ Soil Mixing (ISESM)	Use of large-diameter augers to physically disturb the subsurface, with the introduction of hot air, steam, peroxide, or other fluids to promote contaminant removal or destruction. Soil mixing can be combined with many variations such as vapor extraction and ambient air injection, vapor extraction and hot air injection, hydrogen peroxide injection, ZVI injection and grout injection for solidification/stabilization.	SSM with injection of an oxidant may be effective for treatment of PCBs and PAHs though bench and pilot testing would be needed.	Implementable	High cost when the SSM is combined with in situ oxidation.	Not retained. Not cost effective for relatively low concentrations and broad shallow contamination found onsite.
	Phytoremediation	Use of plants and their associated rhizospheric microorganisms to remove, transfer, stabilize, and/or destroy COCs in soil or groundwater.	The depth of the treatment zone is determined by root depth of the plants or trees used (e.g. Polar max depth 15 feet). Limited to shallow soils because roots must contact contamination. Effectiveness varies seasonally in Illinois climate.	Requires a large surface area for an extended period of time. High concentrations of hazardous materials can be toxic to plants. It is still in the demonstration stage and has not met widespread regulatory approval.	Low to moderate.	Not retained due to the plans for future site development and anticipated timeframe. Not applicable to sediments.

TABLE 3-2  
Remedial Technology Screening – Soil and Sediment  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical-Chemical Treatment	Surfactant/Cosolvent Flushing (Soil Flushing)	Delivery of a solution with wash-improving additive that enhances the physical displacement, solubilization, or desorption of COCs. Flushing solutions include plain water sometimes augmented by surfactants, cosolvents, or other facilitators.	Poor. PCBs and PAHs are difficult to solubilize and flush to extraction system. Potential exists for spreading of the contaminants to deeper soil zones.	Developing technology. Laboratory and field pilot studies must be performed under site-specific conditions before selected as the remedy. Requires greater understanding of the site's geology than some other technologies. Would require solution to be placed on the surface to impact depth of soil contamination.	Moderate to high, O&M intensive. Less cost-effective for organic materials. The treated water could be recycled for use in the flushing solution. Application necessitates extensive pre-design data collection and treatability studies. Generalized costs are approximately \$75 to \$210 per ton of impacted soil or estimated at \$75-200 /cubic yard of impacted material.	Not retained. Poor effectiveness for PCBs and PAHs. Not well suited for shallow depth of soil contamination found onsite. Depth of COCs at the site is primarily limited to the first two feet of soil, so flushing would potentially transport COCs through currently uncontaminated, unsaturated soil.
	Solidification/Stabilization (S/S)	COCs are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Auger/caisson systems and injector head systems are used to apply S/S agents to in-situ soils.	PCBs are already of limited mobility in soil. Not applicable to in situ treatment of PCBs in sediment.	Solidification of shallow soils would limit ability of soils to support vegetation and render the soil unsuitable for certain structural loading or excavation. Not currently applicable to in situ treatment of sediments. Requires pilot testing to determine what, if any reagent is suitable.	O&M and capital intensive. Bench and pilot-scale testing likely required prior to field implementation. The in situ soil mixing/auger techniques average \$40 to \$60 per cubic yard for the shallow applications. The shallow soil mixing technique processes 40 to 80 tons per hour on average.	Not retained. Changes physical characteristics of soil such that future development may be hindered or prevented. Not applicable to sediments.
	Vitrification (ISV)	ISV is a process which uses an electric current to melt soil or other earthen materials at extremely high temperatures (1,600 to 2,000 °C or 2,900 to 3,650 °F) to form a glass and crystalline structure with very low leaching characteristics. The vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock.	PCBs are already of limited mobility in soil. Not applicable to in situ treatment of PCBs in sediment.	There have been few commercial applications of ISV. Application changes physical characteristics of soil and may render them unsuitable for some future uses, such as structural loading, excavation, and ability to support vegetation. Requires pilot testing.	Very high. For ISV, average costs for treatability tests for PCBs and dioxins is \$30K plus analytical. Equipment mobilization and demobilization costs are \$200K to \$300K combined.	Not retained. Changes physical characteristics of soil such that future development may be hindered or prevented. Technology not readily available.
	Chemical Oxidation/Reduction	Oxidation/Reduction agents applied to impacted soil to reduce or oxidize COCs.	Organic content may reduce effectiveness and/or require additional volume of reagent. Not as effective for PCBs as for other organic compounds.	In-situ process requires delivery of a reagent into the subsurface and direct contact with COCs. While surficial soils provide easy access to COCs, injection in shallow soils difficult to safely implement.	High. Estimated costs range from \$150 to \$500 per cubic yard.	Not retained due to the questionable effectiveness on PCBs and depth of COCs in soil.
Thermally Enhanced SVE	Electrical Resistance Heating/Six Phase Soil Heating/Radio Frequency Heating/Steam Heating	Variety of heating methods to promote steam generation to vaporize target compounds. Vapors recovered in a SVE system and treated as needed to remove VOCs from air discharge.	Most technologies are in the development stage. Limited effectiveness on PCBs and shallow depth of COCs.	Implementable	High. Available data indicate the overall cost for thermally enhanced SVE systems is approximately \$25 to \$100 per cubic yard.	Not retained. SVE not a suitable technology for PCBs and depth of COCs.
<b>Ex Situ Treatment</b>						
Biological	Biopiles	Biopile treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Biopiles are relatively simple and require few personnel for operation and maintenance. Typical costs with a prepared bed and liner are \$100 to \$200 per cubic yard.	Not retained due to the questionable effectiveness on PCBs.

**TABLE 3-2**  
*Remedial Technology Screening – Soil and Sediment*  
 OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical/Chemical	Composting	Impacted soil is excavated and mixed with bulking agents and proper organic amendments such as wood chips, hay, manure, and vegetative (e.g., potato) wastes to ensure adequate porosity and provide a balance of carbon and nitrogen to promote thermophilic, microbial activity.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Estimated costs for full-scale windrow composting of explosives-impacted soils are approximately \$190 per cubic yard for soil volumes of approximately 20,000 yd <sup>3</sup> .	Not retained due to the questionable effectiveness on PCBs.
	Land Farming	Impacted soil, sediment, or sludge is excavated mixed with soil amendments, applied into lined beds, and periodically turned over or tilled to aerate the waste. Usually incorporates liners and other methods to control leaching of COCs.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Costs prior to treatment (assumed to be independent of volume to be treated): \$25,000 to \$50,000 for laboratory studies; \$100,000 to \$500,000 for pilot tests or field demonstrations. Cost of prepared bed (ex situ treatment and placement of soil on a prepared liner): Under \$75 per cubic yard.	Not retained due to limited effectiveness on PCBs.
	Chemical Oxidation/Reduction	Oxidation/Reduction agents applied to impacted soil to reduce or oxidize COCs.	Organic content may reduce effectiveness and/or require additional volume of reagent. Not as effective for PCBs as for other organic compounds.		Estimated costs range from \$150 to \$500 per cubic yard.	Not retained due to the questionable effectiveness on PCBs.
	Reductive Dehalogenation: Based-Catalyzed (BCD) or Glycolate	Impacted soil is screened, processed with a crusher and pug mill, and mixed with NaOH and catalysts (BCD) or alkaline polyethylene glycol (APEG) reagent. The mixture is heated in a rotary reactor to dehalogenate and partially volatilize the contaminants or render them nonhazardous. Vapors from the heating process are collected and treated as needed.	Effective but is not typically applied to relatively low PCB concentrations because of high cost.	Transportable technology that can be brought onsite. The process employs off-the-shelf equipment and requires less time and space to mobilize, set up, and take down than an incinerator.	Very high. The cost for full-scale operation is estimated to be in a range of \$200 to \$500 per ton and does not include excavation, refilling, residue disposal, or analytical costs.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Separation	Separation techniques concentrate impacted solids through physical and chemical means. These processes seek to detach compounds from their medium (i.e., the soil, sand, and/or binding material that contains them).	May be effective but is not typically applied to relatively low PCB concentrations because of high cost.	Transportable technology that can be brought onsite. The process employs off-the-shelf equipment and requires less time and space to mobilize, set up, and take down than an incinerator.	Moderate to high.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Soil Washing	COCs sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. Wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics. It does not destroy or immobilize the contaminants. Consequently, the resulting concentrated soil must be disposed of carefully.	Considered a transfer technology in that the contaminants are not destroyed, but transferred to another media. Varying concentrations and mix of COCs at the site creates a complex washing solution. There is a limited volume of soil and sediment greater than 50 mg/kg. Reduction to below 1 mg/kg may require multiple washings.	Pilot/bench scale testing would be required.	High. The average cost for use of this technology, including excavation, is approximately \$170 per ton, depending on site specific conditions and the target waste quantity and concentration.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.

**TABLE 3-2**  
**Remedial Technology Screening – Soil and Sediment**  
**OMC Plant 2 FS**

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex situ S/S typically requires disposal of the resultant materials.	PCBs and PAHs are already of limited mobility in soil or in dewatered sediment.	Implementable although solidified soil and sediment could not be used to support vegetation.	Moderate. \$40 to \$60 per cubic yard.	Not retained. Solidification not needed for limited mobility constituents prior to disposal.
	Chemical Extraction	Soil and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed in a separator, where the COCs and solvent are separated for treatment and further use.	Effective for high concentrations of PCBs. Less effective for relatively low concentrations found onsite. Considered a transfer technology in that the contaminants are not destroyed, but transferred to another media. There is a limited volume of soil and sediment greater than 50 mg/kg. Reduction to below 1 mg/kg may require multiple applications.	Commercial-scale units are in operation.	High. Capital costs can be relatively high, but technology can be cost effective for very high PCB concentrations and large volumes of soil and sediment. Cost estimates for this technology range from \$100 to \$400 per ton, depending on the volume of soil treated.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Sonoprocess	The sediment is slurried in hydrocarbon matrix. Free water is removed and the slurry readied for chemical destruction of the PCB. The reagents and slurry are pumped through a sonic reaction chamber. The reagent de-chlorinates the PCB to leave non-toxic benzene molecules. The solvent is recycled by washing and filtering until disposal as an industrial fuel.	Effective though limited applications to date.	Technology is emerging. Proprietary process of a vendor.	High overall cost. Geared toward smaller quantities of highly contaminated soil.	Not retained. Not cost effective for relatively low concentrations found onsite.
	Thermal Desorption	Soils and sediments are heated in a chamber to high temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Very effective. Provides a physical separation of VOCs. Not designed to destroy organics. HTTD has been proven to remove greater than 99% of PCBs in contaminated soil.	Technology is commercially available.	High Capital and O&M cost because feed rate is constant and requires moving the soil before and after treatment. Rates vary from \$40 to \$300 per ton of soil. Also requires mob/demob of equipment.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
Thermal	Onsite Incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) PCBs and SVOCs.	Good.	There are few mobile incinerators commercially available to treat PCBs and dioxins.	Mobile units that can be operated on-site will reduce soil transportation costs. Soils impacted with PCBs or dioxins cost \$1,500 to \$6,000 per ton to incinerate. There are specific feed size and materials handling requirements that can impact applicability or cost at specific sites.	Not retained. A mobile incinerator is not cost effective for the limited volume and relatively low contaminant concentrations in the soil and sediment.

TABLE 3-2  
Remedial Technology Screening – Soil and Sediment  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Offsite Incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) PCBs and SVOCs.	Good.	Potential risk of transporting the hazardous waste. Three offsite incinerators in the US permitted for PCBs.	Soil treatment costs at off-site incinerators range from \$200 to \$1,000 per ton of soil, including all project costs. Soils impacted with PCBs or dioxins cost \$1,500 to \$6,000 per ton to incinerate. There are specific feed size and materials handling requirements that can impact applicability or cost at specific sites.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
Removal						
Excavation	Excavation	Excavation of soil and sediment using ordinary construction equipment.	Very effective. Unsaturated soil within normal range of excavation equipment (0-8 feet). Very few obstructions to excavation at the site.	Good.	Moderate. Cost estimates for excavation and disposal range from \$50 to \$200 per ton, including excavation/removal, transportation, and disposal.	Retain for further evaluation.
Disposal						
Land Application	Land Application	Soil and sediment placed on land so it can be degraded, transformed, or immobilized.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Good.	Similar to excavation.	Not retained. Not effective for primary contaminants of concern SVOCs and PCBs found at the site.
Onsite Consolidation		Onsite consolidation of soil and dewatered sediment into a berm along north side of site.	Effective assuming soils and sediments are covered with clean soil and vegetated because of very limited mobility characteristics of PCBs and PAHs.	Implementable though engineering characteristics of existing containment cells in area needs to be considered.	Low	Retain for further evaluation.
Landfill	TSCA or RCRA Subtitle C Landfill	Solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill.	Good.	There are suitable landfills within relative proximity of the site.	Moderate to high. Variable but typically exceed \$50/ton.	Retained for further evaluation.
	Subtitle D Solid Waste Landfill	Solid nonhazardous wastes are permanently disposed of in a non-RCRA landfill.	Good.	There are suitable landfills within relative proximity of the site.	Moderate. Disposal costs typically range from \$20 to \$50/ ton.	Retained for further evaluation.

Note:  
COC = Compounds of concern  
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.

### 3.5.1 Containment

As shown in Table 3-2, covering or capping the PCB- and PAH-contaminated soils in-place was not considered a viable technology because the site is intended for future residential development, and the soil and sediment contamination is relatively shallow, limited in extent, and can be cost effectively removed.

### 3.5.2 Chemical Extraction Treatment

Chemical extraction is a process where soil and a solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed into a separator, where the COCs and solvent are separated for treatment and further use or disposal. One advantage of chemical extraction is the reduction of waste; however, chemical extraction does not destroy wastes. The COCs extracted from the soil or sediment typically require another step in treatment or disposal.

Sonoprocess™ is a proprietary process specifically targeted for the chemical destruction of PCBs. The soil or sediment is mixed with water to create slurry. The reagents and slurry are pumped through a sonic reaction chamber. The reagent dechlorinates the PCBs to leave nontoxic benzene molecules. The solvent is recycled by washing and filtering until disposal as an industrial fuel.

If solvent extraction is used for PCBs and other chlorinated compounds, concentrations of these contaminants in the solvent must be kept very low if the resulting solvent is going to be burned. Burning may cause the formation and release of dioxins and furans. If acid extraction is used, the acid needs to be neutralized in the treated soil or sediment.

Chemical extraction is capital intensive and requires multiple steps. The soil would require excavation, material separation/sieving, premixing, separation, possible post-treatment, and disposal onsite (soil/sediment) and disposal offsite (byproducts). Several pieces of equipment and a large working area are required to process the soil, resulting in high mobilization and demobilization costs. These costs are more readily justified when large volumes of soil and high contaminant concentrations are slated for treatment because the economy of this method is recognized when larger volumes do not require transportation and disposal offsite. Considering the relatively low volume of soil and sediment and relatively low concentrations of contaminants in the soil at the OMC site, the chemical extraction technologies were not retained for further consideration because of the relatively higher overall cost.

### 3.5.3 Thermal Desorption and Incineration

Thermal treatment uses heat to volatilize organic compounds and remove them from the soil. Heat is applied through natural gas or other fuel combustion with direct heat transfer to the soil media in a rotary or asphalt kiln. (Indirect methods are less common.) Excavated soil or sediment is processed and fed to the thermal treatment device and the treated soil is then stockpiled and eventually backfilled at the site.

Similar to chemical extraction methods, high-temperature thermal desorption is capital intensive and requires multiples steps (although fewer steps than chemical extraction). In addition, air emission control would be necessary. The system air emission controls would

include a cyclone particulate removal device for emissions exiting the kiln to protect the baghouse used for fines removal. Following the baghouse, the air emissions would be treated in a natural gas-fired incinerator (afterburner) to oxidize the desorbed organics. Air emission controls can add significant cost to the method because of the treatment required to remove dioxins and furans.

In incineration, high temperatures are used to volatilize and combust halogenated and other refractory organics (1,400 to 2,200°F). Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is different from other thermal technologies in that it oxidizes bulk quantities of waste that may be in liquid and solid phase. Incineration is used to remediate soils and sediments impacted with, among other constituents, chlorinated hydrocarbons, PCBs, and dioxins.

There are only three incinerators in the United States that hold a TSCA permit to incinerate PCB-contaminated materials. These facilities are located in Texas and Utah. Transportation of the contaminated soil and sediment to these facilities would be required for offsite incineration, which would result in a relatively high transportation cost compared to other alternatives.

Considering the relatively low volume of soil and relatively low concentrations of contaminants in the soil at the OMC site, thermal treatment was not retained for further consideration because of the air emission requirements and resulting high overall cost.

#### **3.5.4 Disposal**

One process option selected for disposal of untreated excavated soils and sediments at the site is containment under the soil cover on site in a berm along the northern site boundary. PCB soils and sediments exceeding 50 mg/kg will be disposed offsite at an approved TSCA landfill.

The other process option is offsite disposal of all excavated soil and sediment above PRGs. Material less than 50 mg/kg PCBs would be disposed in a Subtitle D landfill, while other material equal to or exceeding 50 mg/kg will be disposed offsite at an approved TSCA landfill. Offsite disposal at a landfill would involve excavation and transportation of the soil and sediment to an appropriately permitted facility. There are Subtitle D and Subtitle C landfills in Illinois and some adjoining states in relative proximity to the OMC site.

Disposal was retained as an option because of the comparatively low cost, availability of disposal facilities, and relatively low concentrations of contaminants at the site.

### **3.6 Technology and Process Option Screening for DNAPL**

Using the same methodology described in the preceding sections, Table 3-3 presents the screening of technology types and process options available for remediation of DNAPL. Potentially feasible technologies and process options for each general response action for remediation of DNAPL at the OMC site include the following:

- No further action

- Institutional controls: deed restrictions, permits, and monitoring
- In situ treatment: chemical reduction, electrical resistance heating, and thermal desorption
- Collection: vertical wells, horizontal wells
- Excavation of DNAPL soils
- Offsite incineration of collected DNAPL and DNAPL soil

The rationale for selecting these process options is indicated in Table 3-3. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These include the in situ treatment, DNAPL collection, and excavation, technology process options.

### 3.6.1 In Situ Treatment

Remedial technologies evaluated as part of the in situ response action for DNAPL at the OMC site are summarized below.

#### Chemical Reduction

Amendments such as emulsified zero-valent iron (ZVI) or bentonite with ZVI are delivered into the DNAPL area using soil mixing methods. Soil mixing allows for treatment of the DNAPL in situ and/or stabilizes the DNAPL to limit the potential for future migration. The ZVI component will also treat the dissolved phase in the immediate area of the DNAPL to reduce the potential for a dissolved phase contaminant plume.

Soil mixing is also effective for residual DNAPL. Because residual DNAPL does not flow and cannot be removed by pumping, soil mixing effectively distributes the treatment amendments throughout the residual DNAPL zone. The cost of soil mixing is moderate due to the specialized equipment required to mix soil at a depth of 30 feet bgs and is primarily affected by the volume of the DNAPL area.

#### Thermal Treatment

In situ thermal treatment remedial technologies include two process options, electrical resistance heating and in situ thermal desorption.

**Electrical Resistance Heating.** Resistance heating generates physical conditions in the subsurface that enhance the release of contaminants from the subsurface. Heat is generated by installing electrodes into the subsurface and passing a current between the electrodes. The natural resistance of the soil results in subsurface heating. The heated contaminants are then collected near the ground surface as steam or extracted by pumping. The steam is condensed while VOCs remain primarily in the vapor phase are treated and released. The cost of electrical resistance heating is moderate to high and is primarily affected by the volume of the area to be treated and the inflow of cold water from the aquifer extending the time to heat the treatment area to the target temperature.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
<b>No Action</b>						
None	None	No action.	None	Implementable	Zero	Required for comparison.
<b>Institutional Controls</b>						
Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property, source area, and/or downgradient groundwater exceeding the clean up goals to restrict groundwater and land use.	Good	Good	Low	Retain. Needed to ensure groundwater is not used until MCLs are attained.
	Permits	Regulations promulgated to require a permit for various activities (i.e., installation of wells, etc.).	Good	Good	Low	Retained.
Alternative Water Supply		Variety of alternate water supply methods used to replace contaminated water supply. Not applicable to OMC site though because groundwater is not used as a water supply.	Good	Good	Moderate capital cost and high O&M	Not applicable. Drinking water is already supplied to residence by the city.
Monitoring		Short-and/or long-term routine monitoring is implemented to record site conditions, concentration levels, and natural attenuation parameters.				Critical to monitor effectiveness of any action.
<b>Containment</b>						
Vertical Barriers	Slurry Walls	Trench around impacted area is excavated and filled with a slurry of low permeability material to provide a barrier.	Very effective for sites where containment of contaminant plumes threatening downgradient receptors is the primary remedial objective. At OMC the primary objective is to return groundwater to MCLs. Downgradient migration is very slow and the plume is not discharging to the harbor or lake. As a result, containment technologies for groundwater do not meet the remedial objectives.	Slurry walls are typically placed at depths up to 100 feet and are generally 2 to 4 feet in thickness. Installation depths over 100 ft are implementable using clam shell bucket excavation, but the cost per unit area of wall increases by about a factor of three. Slurry walls have been used for decades, so the equipment and methodology are readily available and well known; however, the process of designing the proper mix of wall materials to contain specific contaminants is less well developed.	Moderate - Costs escalate with depth. Costs likely to be incurred in the design and installation of a standard soil-bentonite wall in soft to medium soil range from \$6 to \$8 per square foot. These costs do not include variable costs required for chemical analyses, feasibility, or compatibility testing. Testing costs depend heavily on site-specific factors.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs. Slurry walls are not applicable to temporary containment needed for DNAPL excavation alternative.
	Vibrating Beam	Vibratory force used to advance steel beam into the ground. A relatively thin wall of cement or bentonite is injected as the beam is withdrawn.	Continuity of wall is difficult to assess and leakage may occur.	Good, shallow depth to confining unit reduces potential for complications.	High. High capital costs for installation equipment.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Grout Curtains	Grout pressure-injected along contamination boundaries in a regular overlapping pattern of drilled holes.	Continuity of wall is difficult to assess and leakage may occur.	Good, shallow depth to confining unit reduces potential for complications.	Moderate	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Sheet Piling	Interlocking steel piles are driven into subsurface along the boundaries of the impacted area. At OMC sheet piling would be used as temporary shoring for DNAPL excavation.	Very effective for temporary shoring of soil during excavation.	Implementable to depths of about 30 feet needed at site.	Moderate	Not retained for containment of groundwater. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs. Retained as a component of DNAPL excavation alternative to provide temporary shoring of excavation sidewalls.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
In Situ Treatment						
Chemical	Chemical Oxidation (ISCO)	Aqueous injection of oxidizing agents (peroxide/iron, permanganate, persulfate, or ozone) to promote abiotic in situ oxidation of chlorinated organic compounds.	Effective, requires good contact between target contaminant and reagent.	Commercially available. Moderate health and safety concerns depending on oxidant selected. High organic content in some groundwater samples would reduce efficiency.	Moderate to high. More costly than reductive processes because anaerobic groundwater would require much higher oxidant dosage to overcome the reducing environment. Oxidation is also not cost-effective for low-concentration dissolved VOC plumes.	Not retained. Anaerobic reductive dechlorination processes are more suitable to the present reducing environment in groundwater.
	Chemical Reduction (ISCR)	Aqueous injection of reducing agents (zero-valent iron, bio-available carbon, hydrogen) to promote abiotic in situ reduction of chlorinated organic compounds.	Effective in treating site COCs. Most suitable as a source area treatment for high concentration groundwater.	Well developed technology with minimal equipment requirements.	Considered to have good potential for cost-effectiveness for source zones but is costly for low concentration plumes.	Retained for further evaluation in DNAPL and source areas.
	Permeable Reactive Barriers (Passive Treatment Walls)	Permeable treatment units are installed across the flow path of impacted groundwater. As groundwater moves through the treatment wall, COCs are passively removed in the treatment zones by chemical and/or biological processes.	Very effective for sites where containment of contaminant plumes threatening downgradient receptors is the primary remedial objective. At OMC the primary objective is to return groundwater to MCLs. Downgradient migration is very slow and the plume is not discharging to the harbor or lake. As a result, containment technologies for groundwater do not meet the remedial objectives.	Easily implementable at depths of 30 feet or less.	Moderate to high. Where applicable, considered a cost-effective alternative to conventional remedial action technologies.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
Physical	In-well Air Stripping (Circulating Wells)	Groundwater is aerated and lifted within a well bore, re-infiltrates through a different strata of the formation, and creates groundwater circulation. At OMC two systems would be needed because there is substantial difference between the shallow and deep aquifer permeability.	Effectiveness is effected by poor development of circulation zones due to heterogeneities in aquifer permeability. Typically, in-well air stripping systems are a cost-effective approach for remediating VOC-contaminated ground water at sites with deep water tables because the water does not need to be brought to the surface. Operate more efficiently with horizontal conductivities greater than 10-3 cm/sec and a ratio of horizontal to vertical conductivities between 3 and 10. A ratio of less than 3 indicates short circulation times and a small radius of influence. If the ratio is greater than 10, the circulation time may be unacceptably long.	Requires close well spacing, high iron concentrations may result in fouling.	Moderate to high. Extensive system capital investment required relative to alternatives.	Not retained due to the potential for well screen clogging and the need for separate shallow and deep systems as a result of the differing permeability.
	Air Sparging	Air is injected into saturated media to remove COCs through volatilization. May also be used at lower air flow rates to promote biodegradation of petroleum VOCs. Often coupled with SVE for collection/treatment of displaced VOCs.	Effective with tight well spacing (25' or so) in permeable, homogeneous media; significantly less effective in low permeability soils or stratified soils. Favors large saturated thickness and depth to groundwater (greater than 5 feet). Methane can be used as an amendment to the sparged air to enhance cometabolism of chlorinated organics.	Requires close well spacing, high iron concentrations may result in fouling.	Low to moderate. Generally considered cost-effective where applicable.	Not retained due to the presence of NAPLs at the site. Also the shallow groundwater table makes the technology impractical. Unknown piping networks beneath the building may cause migration of vapors.

**TABLE 3-3**  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Horizontal Barriers	Permeability Reduction Agents	Cement grout or organic polymer injected into the soil matrix to reduce permeability.	Experimental process option.	Good in the shallow portion of the aquifer and moderate in the low portion of the aquifer where permeability is reduced.	Moderate	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Ground Freezing (Cryocell process)	Ground freezing technology is used to form a flow-imperious, removable, and fully monitored ice barrier that circumscribes the contaminant source in situ	Short term effectiveness has been reported.	Requires piping installation, limited inflow of warm water, low groundwater velocity is best	High. High capital costs and high O&M costs.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Block Displacement	Controlled injection of slurry in notched injection holes produces a horizontal barrier beneath contamination.	Experimental process option.	Moderate.	High.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Grout Injection	Grout pressure injected at depth through closely spaced drilled holes.	Effective for small areas	Good	Moderate. Equipment intensive.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Ground Freezing	Similar to vertical barriers by ground freezing.	Experimental process option.	Moderate.	High.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
Hydraulic	Liners	Liners placed to restrict vertical flow can be constructed of the same materials considered for cap construction.		Poor	Moderate.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Vertical Wells	Conventional groundwater extraction is pumping in vertical wells. Other extraction device include vacuum enhanced recovery, jet-pumping systems, etc.	Widely used and demonstrated effectiveness. Generally effective for hydraulic containment (i.e., horizontal migration) and ineffective for groundwater restoration.	Good. Common technology; often combined with other treatment technologies applied to the extracted groundwater in an integrated system.	Considered moderately cost-effective; good cost-effectiveness at lower permeability sites.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Horizontal Wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Widely used and demonstrated effectiveness. Increasingly applied technology for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Requires sufficient area at one end of well for equipment and angled penetration. Often combined with other treatment technologies applied to the extracted groundwater in an integrated system	Significantly higher than vertical wells.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect groundwater.	Drains are not suited to high permeability formations where extraction wells are more effective.	Requires sufficient area and access. Often combined with other treatment technologies applied to the extracted groundwater in an integrated system	Low to Moderate depending on depth to groundwater. May require long piping runs to transfer collected groundwater to treatment system or discharge point.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.
	One-pass trenching	Trenches backfilled with granular material provide preferred flow path for collection in pipe or sump. Groundwater collection technique to increase production rate from low permeability areas.	Widely used and demonstrated effectiveness. Effective for increasing groundwater production rate from low permeability areas. Used where aquifer is heterogeneous.	One-pass trenching limited to depths of 25 feet or less. Requires absence/removal of obstacles (e.g. utilities) along trench alignment.	Where implementable, less costly than traditional trenching methods (except small sites). Trenches are excessively costly in bedrock.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to MCLs.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Biological	In-Situ Thermal Desorption (ISTD)	The aquifer is heated in situ with heating elements. The heating results in vaporization of water and constituents for collection by a heated vapor extraction well.	Effective for treatment of VOCs and SVOCs in soils and groundwater with low gradients.	Implementable. Requires accurate conceptual model to ensure heating elements are installed below contamination, vapor migration outside of collection area is a concern, potential to mobilize DNAPL.	High capital and O&M costs for equipment and power. If NAPL is recovered disposal and treatment costs increase.	Retained for further evaluation in DNAPL and source areas.
	Dynamic Underground Stripping (DUS)	A combination of in-situ steam injection, electrical resistance heating and fluid extraction to enhance contaminant removal from the subsurface. Similar to Enhanced Soil Vapor Extraction, except that it also treats groundwater contamination.	DUS has been effectively used for high concentration source areas. High cost makes it unsuitable to low concentration dissolved phase contamination.	Implementable. Treated soils can remain at elevated temperatures for years after cleanup stimulating re-growth of biological community. Soil venting can accelerate the cooling process. DUS/HPO is being field tested at several sites. Additional data on long-term routine operating experience with DUS/HPO is needed to better plan future applications	Very high costs due to relatively extensive capital system requirements, but becomes more cost-effective in larger applications.	Not retained due to more cost effective options available for site contaminants.
	Enhanced Reductive Dechlorination	Subsurface delivery of electron donors (hydrogen, lactate, food-grade oils, corn syrup, etc.) within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Very effective when used to enhance existing anaerobic conditions for remediation of CVOCs. Typically applied to high concentration source areas rather than low dissolved phase groundwater contamination.	Implementable. Site-specific bench and/or pilot-scale testing recommended, relies on advective transport of amendments.	Low to Moderate Will in many cases be more cost-effective than aerobic process since maintenance of aerobic conditions is not required.	Retained for further evaluation for groundwater.
	Natural Attenuation	Short-and/or long-term routine monitoring is implemented to record site conditions, concentration levels, and natural attenuation parameters. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce concentrations to acceptable levels.	Good, demonstrated to be occurring at the PMC site. Less generation or transfer of remediation wastes; Less intrusive as few surface structures are required; May be applied to all or part of a given site, depending on site conditions and cleanup objectives; Natural attenuation may be used in conjunction with, or as a follow-up to, other (active) remedial measures; Overall cost will likely be lower than active remediation. Longer time frames may be required to achieve remediation objectives, compared to active remediation.	Good regulatory agency acceptance.	Generally, the lowest cost alternative were applicable. The most significant costs associated with natural attenuation are most often due to monitoring requirements.	Retained for further evaluation for groundwater.
Collection	Phytoremediation	Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in ground water, surface water, and leachate. These mechanisms include enhanced rhizosphere biodegradation, hydraulic control, phyto-degradation and phyto-volatilization.	Not effective for remediating groundwater to depths of 30 feet bgs as is needed at OMC.	Most applicable for control of shallow groundwater plumes. High concentrations of hazardous materials can be toxic to plants.	Low to moderate. Where applicable, considered one of the most cost-effective options available. Construction estimates for phytoremediation are \$200K/acre and \$20K/acre for operations and maintenance	Not retained due to ineffectiveness in treating groundwater to depths of 30 feet as needed at OMC.
	Hydraulic Vertical Wells	Conventional groundwater extraction is pumping in vertical wells. Other extraction device include vacuum enhanced recovery, jet-pumping systems, etc.	Widely used and demonstrated effectiveness.	Implementable.	Low. Least cost groundwater extraction tech technology.	Retained for further evaluation for DNAPL and groundwater.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Dual phase extraction (DPE)	DPE is a technology that uses a high vacuum system to remove liquid (i.e., NAPL, contaminated groundwater) and soil vapor. The main purpose of the system is to lower the water table using high vacuum or groundwater pumping to expose the aquifer matrix to more rapid remediation via soil vapor extraction. Once above ground, the extracted vapors, liquid-phase organics, and/or groundwater are separated and treated.	Combination with complementary technologies (e.g., pump-and-treat) may be required to recover ground water from high-yielding aquifers. Use of DPE with these technologies can shorten the cleanup time at a site, as the capillary fringe is often the most contaminated area.	DPE is a full scale technology and commercially available.	Moderate. Because of the number of variances involved, establishing general costs for dual phase extraction is difficult. Estimated cost are about \$50 to \$100 /cy.	Not retained due to difficulty in dewatering the relatively permeable aquifer.
	Bioslurping	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts LNAPLs from the capillary fringe and the water table.	Bioslurping is not applicable at sites such as OMC without LNAPL or aerobically biodegradable COCs.	Presence of subsurface piping may result in short-circuiting of system.	Low to moderate.	Not retained due to absence of LNAPL and presence of COCs that are not amenable to aerobic degradation.
	Pneumatic fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor and fluid extraction technologies. The fracturing extends and enlarges existing fissures and introduces new fractures, primarily in the horizontal direction.	Effective in low permeability aquifers to increase permeability. Fracturing is an enhancement technology designed to increase the efficiency of other in situ technologies in difficult soil conditions. Tests results indicate that PF has increased the effective vacuum radius of influence nearly threefold and increased the rate of mass removal up to 25 times over the rates measured using conventional extraction technologies. In addition, numerous bench-scale and theoretical studies have been published.	Fracturing is widely used in the petroleum and water-well construction industries and is commercially available for remediation activities.	Moderate. Equipment intensive.	Not retained because aquifer already has sufficient permeability.
	Hydraulic fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor or fluid extraction technologies.	Effective in low permeability aquifers to increase permeability. Fracturing is an enhancement technology designed to increase the efficiency of other in situ technologies in difficult soil conditions.	Fracturing is widely used in the petroleum and water-well construction industries. It is commercially available for use in hazardous waste remediation.	Moderate. The cost per fracture is estimated to be \$1,000 to \$1,500, based on creating four to six fractures per day.	Not retained because aquifer already has sufficient permeability.
	Hot Water or Steam Flushing/Stripping (i.e., Hydrous Pyrolysis/Oxidation (HPO))	Steam is forced into an aquifer through injection wells Vaporized components rise to the unsaturated zone, where they are removed by vacuum extraction and treated.	Increases the rate of VOC removal. The process is applicable to shallow and deep contaminated areas, and readily available mobile equipment can be used.	Implementable though vapor recovery may be difficult due to thin unsaturated zone and presence of piping network below building.	Very high due to heating equipment and power requirements.	Not retained due to extensive subsurface piping network beneath building.
	Electrical Resistance Heating (ERH)	ERH is an electrical resistance heating technology that delivers separate electric phases through electrodes placed in a circle around a soil vent, that promotes in situ generation of steam to vaporize target compounds. Vapors recovered in a SVE system and treated as needed to remove VOCs from air discharge.	Effective for treatment of VOCs in shallow soils.	Implementable. Requires soils remain moist to ensure effective transfer of electricity and heat to aquifer.	High, power consumption costs vary.	Retained for further evaluation in DNAPL and source areas.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical Treatment	Precipitation	This process transforms dissolved compounds into an insoluble solid, facilitating the compound's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation. It is used as a pretreatment process with other technologies (such as chemical oxidation or air stripping), where the presence of metals would interfere with treatment.	Effective in treating metals. Not applicable to site COCs.	Implementable. Commonly applied technology.	Moderate to high. The primary capital cost factor is design flow rate. Capital costs for 20-gpm and 65-gpm packaged metals precipitation systems are approximately \$85,000 and \$115,000, respectively. Operating costs (excluding sludge disposal) are typically in a range from \$0.30 to \$0.70 per 1,000 gallon of ground water containing up to 100 mg/L of metals.	Not retained because it is not applicable to site contaminants.
	Ion Exchange	Ion exchange removes ions from the aqueous phase by the exchange of cations or anions between the contaminants and the exchange medium. Ion exchange materials may consist of resins made from synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. They also may be inorganic and natural polymeric materials. After the resin capacity has been exhausted, resins can be regenerated for re-use.	Does not work well for mixed organic contaminants.	This technology has long been used in industry and is commercially available.	The cost for a typical ion exchange system ranges from \$0.30 to \$0.80 per 1,000 gallons treated. Key cost factors include: Pretreatment requirements, Discharge requirements and resin utilization. Regenerant used and efficiency.	Not retained because it is not applicable to site contaminants.
	Hydrolysis	Destruction of contaminant through hydrolytic breakage of chemical bonds at elevated pH and high temperatures to aid in the breakage of chemical bonds	Requires excessively high temperatures to aid in the breakage of chemical bonds.	Moderate, treatment rates impact O&M requirements.	High, requires high volumes of pH amendments or high energy inputs to raise temperatures.	Not retained due to limited effectiveness on CVOCs.
	Electrochemical Reduction	Electrochemical treatment changes the oxidation state of ions in solution to a preferred and treatable state through the application of an electrolyte solution.	Effective for appropriate contaminants.	Moderate for low flow rates, high flow rates may require additional or larger electrodes.	High	Not retained because it is not applicable to site contaminants.
	Separation	Separation processes seek to detach contaminants from their medium (i.e., ground water and/or binding material that contain them). Ex situ separation of waste stream can be performed by many processes: (1) distillation, (2) filtration/ultrafiltration/microfiltration, (3) freeze crystallization, (4) membrane evaporation and (5) reverse osmosis.	Moderate	Moderate.	High. High capital costs and O&M requirements.	Not retained because more cost effective options are available.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Horizontal Wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Widely used and demonstrated effectiveness. Increasingly applied technology for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Implementable.	Moderate. Significantly higher than vertical wells.	Retained for further evaluation as a component/enhancement of other alternatives for areas beneath the building or in DNAPL area.
	Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect groundwater.	Although they may be effective, drains are not suited to high permeability formations where extraction wells are more effective.	Implementable.	Moderate to high. May require long piping runs to transfer collected groundwater to treatment system or discharge point.	Not retained. Groundwater is more effectively removed from the high permeability aquifer materials using vertical wells.
Removal						
Excavation	Excavation	Excavation of DNAPL impacted soils can use ordinary construction equipment backhoes, bulldozers, and front-end loaders. Excavation of DNAPL soils at depths of 30 feet would require steel sheet piling for stabilizing the excavation walls.	Very effective because limits of contamination can be observed during excavation.	Excavation combined with off-site treatment and disposal of DNAPL soil is well proven and readily implementable technology.	High costs for deep excavation.	Retain for further evaluation for DNAPL soil.
Ex Situ Treatment						
Chemical	Chemical Oxidation (e.g., UV Oxidation)	Oxidizing agents are used to destroy organic contaminants in an ex situ reactor. Potential oxidizing agents are UV radiation, ozone, and/or hydrogen peroxide/ferrous iron, or permanganate.	Proven effectiveness for most CVOCs. Oxidant selection critical as not all oxidants are equally effective on all compounds.	Good. Treatability testing necessary. No residual to regenerate. No VOC air emissions.	High	Retained for further evaluation for groundwater.
	Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight. Contaminants are mixed with a semiconductor catalyst such (e.g., titanium dioxide), and fed through a reactor which is illuminated by sunlight. Ultraviolet light activates the catalyst, which results in the formation of reactive chemicals known as "radicals". These radicals are powerful oxidizers that break down the contaminants into non-toxic by-products such as carbon dioxide and water.	Poor effectiveness for site COCs. would require very large shallow ponds to allow photolysis but most losses would be via volatilization. Could not be operated during winter months.	The technology has been field tested, limited sunlight in this area of the country reduces practicality of this technology.	High	Not retained due to poor effectiveness and operational constraints.
	Chemical Reduction	Reducing agents (zero-valent iron) are used to destroy organic contaminants in an ex situ reactor. For example, CVOCs are reduced to carbon dioxide and water.	Effective for treating site COCs though treatment bed would be very large and costly at the high anticipated flow rates extracted from the aquifer.	Long contact time between reducing agent and groundwater may be required.	Moderate, cost dependent on reducing agent selected and life of reducing agent.	Not retained because other more cost-effective technologies such as air stripping and UV/oxidation are available.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Offsite Incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is different from other thermal technologies in that it oxidizes bulk quantities of waste that may be in liquid and solid phase.	The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99% requirement for hazardous waste and can be operated to meet the 99.9999% requirement for PCBs and dioxins.	Implementable	Very high.	Retained for further evaluation for disposal of collected DNAPL and DNAPL contaminated soil.
Discharge						
Wastewater discharge	Land Application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized.	Poor effectiveness for CVOCs because they are not readily degradable aerobically.	Sufficient space onsite not available and would conflict with future residential land use onsite.	Low to moderate.	Not retained due to lack of effectiveness and land requirements.
	POTW	Aqueous streams are discharged to a POTW for treatment.	VOCs are effectively treated at POTWs to below NPDES discharge requirements.	Implementable provide water meets pretreatment limits.	Low to moderate.	Retained for further evaluation for groundwater.
	Surface Water	Discharge of treated groundwater to nearby surface water body.	Effective though discharge to harbor or Lake Michigan may require additional treatment processes to remove inorganics.	Implementable though it requires meeting the substantive requirements of an NPDES permit.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Reinjection	Reinjection of treated groundwater to the aquifer upgradient or side-gradient to the impacted area.	May increase the effectiveness of aquifer restoration due to increased flow rate through aquifer as a result of reinjection.	Implementable. Reinjected water would likely be required to meet drinking water MCLs.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Evaporation Ponds	Surface impounds are used to contain treated or untreated wastewater or groundwater until it evaporates	Ponds would have to be very large to accommodate flow rate and allow time for sufficient volatilization. Air emissions of VOCs would not be controlled.	Not likely to be implementable due to air emissions and large land requirement.	Low to moderate.	Not retained due to air emissions and land requirements.

Note:  
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.  
Effectiveness is the ability to perform as part of an overall alternative that can meet the objective under conditions and limitations that exist onsite  
Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the physical, regulatory, technical, and schedule constraints.  
Relative cost is for comparative purposes only and it is judged relative to the other processes and technologies that perform similar functions.

TABLE 3-3  
Remedial Technology Screening – Groundwater and DNAPL  
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Offsite Incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is different from other thermal technologies in that it oxidizes bulk quantities of waste that may be in liquid and solid phase.	The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99% requirement for hazardous waste and can be operated to meet the 99.9999% requirement for PCBs and dioxins.	Implementable	Very high.	Retained for further evaluation for disposal of collected DNAPL and DNAPL contaminated soil.
<b>Discharge</b>						
Wastewater discharge	Land Application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized.	Poor effectiveness for CVOCs because they are not readily degradable aerobically.	Sufficient space onsite not available and would conflict with future residential land use onsite.	Low to moderate.	Not retained due to lack of effectiveness and land requirements.
	POTW	Aqueous streams are discharged to a POTW for treatment.	VOCs are effectively treated at POTWs to below NPDES discharge requirements.	Implementable provide water meets pretreatment limits.	Low to moderate.	Retained for further evaluation for groundwater.
	Surface Water	Discharge of treated groundwater to nearby surface water body.	Effective though discharge to harbor or Lake Michigan may require additional treatment processes to remove inorganics.	Implementable though it requires meeting the substantive requirements of an NPDES permit.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Reinjection	Reinjection of treated groundwater to the aquifer upgradient or side-gradient to the impacted area.	May increase the effectiveness of aquifer restoration due to increased flow rate through aquifer as a result of reinjection.	Implementable. Reinjected water would likely be required to meet drinking water MCLs.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Evaporation Ponds	Surface impounds are used to contain treated or untreated wastewater or groundwater until it evaporates	Ponds would have to be very large to accommodate flow rate and allow time for sufficient volatilization. Air emissions of VOCs would not be controlled.	Not likely to be implementable due to air emissions and large land requirement.	Low to moderate.	Not retained due to air emissions and land requirements.

*Note:*  
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.  
Effectiveness is the ability to perform as part of an overall alternative that can meet the objective under conditions and limitations that exist onsite  
Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the physical, regulatory, technical, and schedule constraints.  
Relative cost is for comparative purposes only and it is judged relative to the other processes and technologies that perform similar functions.

**In Situ Thermal Desorption.** Implementation of in situ thermal desorption involves installation of wells followed by installation of heating elements into each well. Heat is applied to the soil by the heating element in close contact with the soil. This differs from resistance heating as no current is passed through the soil. Thermal conduction of the soil transfers heat away from the heated wells. Heated extraction wells are installed to collect vapors generated by the heating of soils and groundwater. The steam is collected and condensed. The condensation is treated and discharged while VOCs remain in the vapor phase which is treated and released. The cost to implement the in situ thermal desorption process option is moderate to high.

### 3.6.2 DNAPL Collection

The DNAPL collection response action, if implemented, could potentially use multiple process options. Active extraction could be useful for collecting mobile, easily extractable DNAPL while passive collection or periodic pumping of a collection “sump” could be more effective for residual DNAPL. Treatment and disposal options are likely limited to offsite incineration. The cost of DNAPL collection is low to moderate and is primarily dependent upon the volume of DNAPL recovered and the cost of disposal.

### 3.6.3 Excavation

The DNAPL excavation response action, if implemented, would utilize a temporary containment alternative such as sheet piling to isolate the DNAPL area. After installation of the sheet piling, the soil within the sheet piling would be excavated to the base of the aquifer effectively removing the DNAPL area. The DNAPL soil would be treated to meet LDRs, most likely with offsite incineration and disposed of offsite as a hazardous waste. The cost of excavation is low to moderate and is primarily dependent on the cost of sheet piling installation/removal and the cost of hazardous waste disposal.

## 3.7 Technology and Process Option Screening for Groundwater

Using the same methodology described in the preceding section, Table 3-3 presents the results of a qualitative comparison of technology types and process options available for groundwater remediation. The response actions and associated process options that were retained after screening for remediation of groundwater at the site include the following:

- No further action
- Institutional controls: deed restrictions, permits, and monitoring
- In situ treatment: chemical reduction, electrical resistance heating, thermal desorption, enhanced reductive dechlorination, natural attenuation
- Collection: vertical wells, horizontal wells
- Ex situ treatment: chemical oxidation, carbon adsorption, air stripping
- Discharge: POTW, surface water, reinjection

The rationale for selecting these process options is indicated in Table 3-3. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These technologies include containment, in situ treatment, ex situ groundwater treatment, and groundwater discharge.

### **3.7.1 Containment**

Containment alternatives were considered as part of the evaluation process. Evaluated alternatives include hydraulic gradient control, sheet piling, slurry walls, and permeable reactive barriers. The findings of the RI indicate groundwater contamination from the OMC site is not discharging to Lake Michigan east of the site. In addition, groundwater analytical results indicate groundwater contamination related to the OMC site is not discharging to Waukegan Harbor. The CVOC migration velocities are very slow, and there is substantial natural attenuation occurring. As a result, the most important remedial objectives for groundwater are returning the groundwater to drinking water standards and preventing indoor exposures from volatilization from the plume.

As a result, hydraulic containment or passive reactive barrier technologies with the objective of preventing offsite migration are not currently needed to protect the harbor or lake and do not meet the more important objectives of groundwater restoration to drinking water standards. These technologies were not retained for inclusion in the remedial alternatives.

### **3.7.2 In Situ Treatment**

In situ treatment process options that were evaluated in more detail include the following:

- In situ chemical oxidation
- In situ chemical reduction
- Enhanced reductive dechlorination
- In situ thermal desorption
- Electrical resistance heating

Each process option is presented in greater detail below. Each of these process options have a relatively high cost and would be applied to the more concentrated portions of the plume.

#### **In Situ Chemical Oxidation**

This technology involves injection of a strong chemical oxidant (ozone, persulfate, permanganate, or peroxide) into the contaminant plume. The ensuing reaction then oxidizes the organic contaminants it comes into contact with. The oxidation reaction can be highly exothermic with stronger oxidants like peroxide. The vapors and steam generated during the reaction could potentially migrate through underground utilities or piping. These concerns can be addressed by using a slightly weaker oxidant such as permanganate; however, permanganate solution and permanganate solid are a dark purple color. The potential for the oxidant to migrate along utility corridors could result in a discharge of dark purple water to nearby surface water bodies.

The implementation cost of in situ chemical oxidation (ISCO) is considered moderate for source areas. The cost to implement ISCO for the dissolved plume exceeding PRGs is considered high. This is largely the result of the high oxidant demand expected because the aquifer is under strongly reducing conditions with a high organic content of the soil and

groundwater. This option was not retained for inclusion in the remedial alternatives due to costs and implementation concerns.

### **In Situ Chemical Reduction**

The in situ chemical reduction (ISCR) process option involves delivering a chemical reducing agent to the subsurface to treat the contaminants. Reducing agents being evaluated include EHC®, Daramend®, and emulsified ZVI. All three reducing agents contain ZVI but vary in the size of the iron particles and the nature of the controlled-release carbon source. The emulsified ZVI is specifically designed to target DNAPL areas. The design of the ISCR amendments is to provide a carbon source to stimulate biological activity while the ZVI provides rapid dechlorination of the CVOCs. The cost of ISCR is estimated at low to moderate and is driven primarily by the longevity of the reducing agents in the subsurface and delivery methods. This option was retained for inclusion in the remedial alternatives.

### **Enhanced Reductive Dechlorination**

Electron donors (hydrogen, lactate, food-grade oils, corn syrup, whey, etc.) are delivered to the subsurface within the target treatment zone to stimulate anaerobic biodegradation of chlorinated solvents by reductive dechlorination. Injection of the substrate would be performed using direct push methods or permanently installed injection wells. The substrate addition would stimulate the native micro-organisms which in turn “consume” the contaminants generating methane/ethane and other byproducts. Injections would be performed periodically to sustain the biological community. The goal of the enhanced bioremediation alternative would be to reduce contaminant concentrations to levels that can be remediated to PRGs by MNA. The cost of this alternative is considered low to moderate. Enhanced reductive dechlorination was retained for inclusion into remedial alternatives.

### **In Situ Thermal Desorption**

In situ thermal desorption's (ISTD's) primary application uses thermal heating wells, along with heated extraction wells. Heat is applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer are effective near the heating element. As a result, thermal conduction and convection expand into the soil volume. The ISTD process creates a zone of very high temperature (greater than 1,000°F) near the heaters, which can oxidize or pyrolyze target constituents. A soil vapor extraction system is used to remove volatilized constituents.

ISTD raises the soil temperature within the treatment volume to the boiling point of water, generating steam in situ. This results in steam distillation of the contaminants. ISTD occurs as vapors are drawn into the hot regions in close proximity to heated extraction wells. The cost of ISTD is high driven primarily by the cost of capital equipment, condensate treatment, and vapor treatment. ISTD was retained for inclusion in the remedial alternatives.

### **Electrical Resistance Heating**

Electrical resistive heating (ERH) operates under the principal that electrical current passing through a resistive component, such as soil, will generate heat. The amount of current which can be made to flow through a given soil type is a function of the voltage applied and the resistance of the soil. Several factors govern the resistance between adjacent Six-Phase

Heating™ (SPH) electrodes including soil type, moisture content, and the distance between electrodes. Since distance and soil types are fixed components, current flow can be controlled by regulating soil moisture content and the applied voltage.

Electrical current is split into multiple (typically three or six) electrical phases for the electrical resistive heating of soil and groundwater. The electrical current is derived from a centrally located transformer and sent to each of electrodes placed in the subsurface. Soil and groundwater are heated to appropriate temperatures, dependant upon soil type, allowing the volatilization of contaminants. Once soil contaminants are volatilized, they are removed from the subsurface media by a soil vapor extraction system, and treated above ground using conventional methods such as oxidation or adsorption.

By heating subsurface material to the boiling point of water, an in situ source of steam is created which strips contaminants from the soil. The steam serves two purposes. First, its physical action drives contaminants out of portions of the soil that tend to lock in the contaminants via capillary forces. Second, the steam acts as a carrier gas for the contaminants, enabling the contaminants to be swept out of the soil into the vacuum vent by increasing the permeability of the soil.

Thermocouples measure soil temperatures at multiple locations within the treatment area at varying depths. The system requires daily manual adjustments of the electrode voltage and SVE system vacuum. An onsite computer is used to adjust voltages on the transformer to maintain a consistent power input. ERH is a full-scale, batch, in situ technology.

Costs for ERH are moderate to high and are driven primarily by the cost of electricity and the area to be treated. ERH was retained for inclusion in the remedial alternatives.

### **3.7.3 Ex Situ Treatment**

CVOCs are the primary contaminant expected to be present in extracted groundwater that will require treatment to discharge standards prior to reinjection or discharge to surface water. Iron and manganese may also be present in groundwater at elevated concentrations as a result of the reducing conditions in the aquifer. The reducing conditions result in the reduction of iron and manganese naturally present in the aquifer soil to soluble forms. Once these inorganics are no longer under reducing conditions, they would be expected to become oxidized back to their immobile forms. Removal of iron and manganese may be necessary prior to discharge to surface water

The most suitable process options identified for treatment of CVOCs are ultraviolet (UV)/oxidation, carbon adsorption (using granular activated carbon [GAC]) and/or air stripping. The cost for ex situ treatment is moderate to high and is driven primarily by the cost of long-term O&M, utility costs, and capital equipment costs. UV/oxidation was retained primarily because of the presence of relatively high concentrations of vinyl chloride. Vinyl chloride, while easily air stripped, is not easily removed with GAC. If emissions from an air stripper require treatment for vinyl chloride, it may be more cost effective to use UV/oxidation because it destroys the vinyl chloride in the water phase. Each of these technologies was retained and will be evaluated further in the alternative development.

#### **3.7.4 Discharge**

Under the discharge response action, the process options of discharge of treated groundwater to the POTW, surface water (North Ditch, South Ditch, Waukegan Harbor) and re-infiltration are retained. Discharge to a surface water such as Lake Michigan or Waukegan Harbor generally has more stringent discharge limits, particularly for inorganics. Each of these discharge options will be evaluated in more detail in the alternative development.

## Alternative Descriptions

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### 4.1 Introduction

The remedial technologies and process options that remain after screening for the building soil and sediment, DNAPL, and groundwater media were assembled into a range of alternatives. The remedial alternatives were developed separately for the building, contaminated soil and sediment, DNAPL, and groundwater to allow a wider range of alternatives and greater flexibility in selecting the recommended alternatives. Soil and sediment media have been combined because the technologies used for each are similar.

The specific details of the remedial components discussed for each alternative are intended to serve as representative examples to allow order-of-magnitude cost estimates. Other viable options within the same remedial technology that achieve the same objectives may be evaluated during remedial design activities for the site. The following sections provide a detailed description of each alternative. The developed remedial alternatives are summarized in Table 4-1.

### 4.2 Building Materials Alternative Descriptions

Four building material alternatives were developed to address present trespasser risk or are likely to overlie contaminated soil. Each of the technologies remaining after screening was incorporated into at least one alternative. For the purposes of this evaluation, building materials are defined as aboveground structures and the concrete slab. The concrete footings and tunnel structures will be left in place. The portions of the building that are uncontaminated including the New Die Cast Area, Trim Building, and Triax Building, and these do not require any remedial action to meet the RAOs (see Figure 2-1).

As previously described in the soil and sediment alternatives, the remediation of unsaturated zone soil below the building slab or adjacent to the building (within 20 feet) will be based on COCs, concentrations, and volume that will be determined once the slab is removed. A soil management plan will present the decision framework; for example, soils with PCBs greater than 50 mg/kg will be sent to a TSCA landfill, PCB soil with less than 50 mg/kg will be sent to a Subtitle D landfill or consolidated onsite, and VOC-impacted soil will be treated.

#### 4.2.1 Building Materials Alternative 1—No Further Action

The objective of Building Materials Alternative 1 (B1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of and exposure to contaminants. There would be a risk to trespassers from direct contact with the building materials if the building was not demolished.

OMC PLANT 2 REMEDIAL ALTERNATIVES TECHNICAL MEMORANDUM

Table 4-1  
Remedial Alternative Development  
OMC Plant 2 Alternatives Array

General Response Actions	Remedial Technology/ Process Option	Building				Soil and Sediment				DNAPL					Groundwater								
		B1- No Further Action	B2- Demolition and Offsite Disposal	B3- Demolition Offsite Disposal and Onsite Consolidation	B4- Demolition Offsite Disposal and Onsite Consolidation with Harbor Sediments	S1- No Further Action	S2- Excavation and Offsite Disposal	S3- Excavation Offsite Disposal and Onsite Consolidation	S4- Excavation Offsite Disposal and Onsite Consolidation with Harbor Sediments	D1- No Further Action	D2- Institutional Controls and Monitoring	D3- Onsite Collection and Offsite Destruction	D4a- In Situ Chemical Reduction Treatment	D4b- In Situ Thermal Treatment	D5- Extraction, Offsite Treatment and Disposal	G1- No Further Action	G2- Institutional Controls and Monitored Natural Attenuation	G3a- Source Zone In Situ Chemical Reduction	G3b- In Situ Enhanced Reductive Dechlorination	G4a- Groundwater Collection and Treatment with Monitored Natural Attenuation	G4b- Groundwater Collection and Treatment to MCLs	G5- In Situ Thermal Treatment	
No Action	None	x				x				x						x							
Institutional Controls	Deed Restrictions			x	x			x	x		x	x	x	x			x	x	x	x			x
	Permits			x	x			x	x		x	x	x	x			x	x	x	x			x
	Monitoring										x	x	x	x			x	x	x	x	x		x
In Situ Treatment	Chemical Reduction (ISCR)												x					x					
	Electrical Resistance Heating (ERH)																						
	In-Situ Thermal Desorption (ISTD)													x									x
	Enhanced Reductive Dechlorination																		x				
	Natural Attenuation																	x	x	x	x		x
Collection	Vertical Wells											x									x	x	
	Horizontal Wells											x									x	x	
Removal	Demolition		x	x	x																		
	Excavation						x								x								
Ex Situ Treatment	High pressure washing, solvent washing, scarifying, wiping		x	x	x																		
	Thermal														x								
	Chemical Oxidation (e.g., UV Oxidation)																			x	x		
	Liquid-Phase Carbon Adsorption																				x	x	
	Air Stripping																				x	x	
	Offsite Incineration										x												
	Onsite Consolidation			x	x				x	x													
Disposal	TSCA/ RCRA Subtitle C Landfill		x	x	x			x	x	x					x								
	Subtitle D Landfill		x					x															
	POTW																				x	x	
Discharge	Surface Water																				x	x	
	Reinjection																				x	x	

## 4.2.2 Building Material Alternative 2—Demolition and Offsite Disposal

The objectives of Building Materials Alternative 2 (B2), demolition and offsite disposal, are the prevention of trespasser human exposure to PCBs, through contact, ingestion, or inhalation on building surfaces and the removal of building materials and concrete slab, as necessary, to allow site remediation.

The main remedial components of B2 include the following:

- Soil management plan
- Demolition
- Disposal

A soil management plan would address remediation of the soil and concrete tunnels found underneath the building. The building's concrete footings would remain in-place. Any concrete tunnels uncovered would be sampled after removal of the slab, and disposal options would be evaluated at that time. If they are found to be uncontaminated, they may be filled with uncontaminated concrete rubble.

Pre-demolition activities include the removal of all roof electrical transformers in accordance with TSCA and decontamination of internal surfaces, as needed, for cost-effective metal and concrete reclamation/disposal. Metal with a PCB concentration less than 10 µg/100 cm<sup>2</sup> can be recycled as scrap. Asbestos abatement would also be conducted.

Demolition of the building structure would be completed next. Building material would be recycled or reclaimed or disposed in a TSCA or Subtitle D landfill.

The concrete slab demolition would be the final step. Concrete with PCB greater than 50 mg/kg would be sent to a USEPA-approved TSCA/Subtitle C landfill. Concrete with PCB less than 1 mg/kg would be crushed and reused offsite if possible or used to fill the underground tunnels.

Building material that is not recycled or reclaimed would be sent offsite for disposal based on the following criteria:

- PCBs less than 50 mg/kg or less than 100 µg/100 cm<sup>2</sup> would be sent to a Subtitle D landfill
- PCBs greater than 50 mg/kg or greater than 100 µg/100 cm<sup>2</sup> would be sent to a USEPA-approved TSCA/Subtitle C landfill

## 4.2.3 Building Material Alternative 3—Demolition, Offsite Disposal, and Onsite Consolidation

Building Material Alternative 3 (B3) is identical to B2 except for the disposal options. In B3, building material with PCBs greater than 50 mg/kg or greater than 100 µg/100 cm<sup>2</sup> would still be disposed in an offsite TSCA/Subtitle C landfill; however, building material with less than 50 mg/kg of PCBs or less than 100 µg/100 cm<sup>2</sup> would be consolidated onsite in a berm.

The berm would be constructed in the area between the existing East and West Containment cells on the northern portion of site. After consolidation of the building material and soils

and sediment is completed, the berm would be covered with 10 inches of clean soil and seeded.

#### **4.2.4 Building Material Alternative 4—Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments**

Building Material Alternative 4 (B4) is identical to B3 except for the disposal options. In B4, building material with PCBs greater than 50 mg/kg or greater than 100 µg/100 cm<sup>2</sup> would still be disposed in an offsite TSCA/Subtitle C landfill; however, building material with less than 50 mg/kg of PCBs or less than 100 µg/100 cm<sup>2</sup> would be consolidated onsite in a berm, but the berm would be constructed along the entire length of the northern property boundary to allow future consolidation of Waukegan Harbor sediments.

New containment sidewalls would be constructed around the existing East and West Containment Cells to allow placement of dewatered sediment and OMC Plant 2 building material, soils, and sediment directly on top. The cells would be modified, as necessary, to allow for the placement of the soil and sediment. After construction of the berm is complete, it would be covered with 10 inches of clean soil and seeded.

### **4.3 Soil and Sediment Alternative Descriptions**

Four soil and sediment media alternatives were developed to address a range of remedial actions and include all the remaining technologies into at least one alternative. The soil and sediment alternatives do not include the unsaturated zone soil below the building slab or adjacent to the building (within 20 feet). Soil adjacent to the building will be included in building demolition. Soil remediation beneath the building will be based on COCs, concentrations, and volume that will be determined once the slab is removed.

#### **4.3.1 Soil Alternative 1—No Further Action**

The objective of Soil Media Alternative 1 (S1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of and exposure to contaminants. There would be a risk from direct contact with the soil if the site was developed in the future for residential use. There would also be ecological risks as described earlier.

#### **4.3.2 Soil Alternative 2—Excavation and Offsite Disposal**

The objective of Soil Media Alternative 2 (S2), excavation and offsite disposal, is to prevent residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil and prevention erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk. The volume of soil to be excavated would be based primarily on the presence of PCBs greater than 1 ppm. PAHs exceeding PRGs are generally included within this area.

Soils exceeding the PRGs are shown in Figures 2-2 through 2-5 and are separated into surface soil (0 to 2 feet) and unsaturated zone soil (2 to 5 feet). The total estimated volume of PCB- and PAH-contaminated soil exceeding PRGs is approximately 36,600 cubic yards. The

total volume of sediment to be excavated is 4,200 cubic yards. The main remedial components of S2 include the following:

- Excavation
- Disposal

Soils exceeding the PRGs would be excavated and segregated by area in separate stockpiles that would be sampled for disposal characteristics. The stockpiles would be managed appropriately until approval for disposal was received. Sediment in the drainage ditches would be excavated and dewatered prior to offsite transport. Excavation and dewatering methods would be determined in design. It will be assumed for the FS-level cost estimates that dry excavation techniques would be used. Dewatering would be assumed to be by gravity dewatering on a lined pad.

Excavated soils and sediment would be sent offsite for disposal based on the following criteria:

- PCBs less than 50 mg/kg would be sent to a Subtitle D landfill
- PCBs greater than 50 mg/kg would be sent to a USEPA-approved TSCA/Subtitle C landfill

#### **4.3.3 Soil Alternative 3—Excavation, Offsite Disposal, and Onsite Consolidation**

Soil Media Alternative 3 (S3) is identical to S2 except for the disposal options. In S3, soils with PCBs greater than 50 mg/kg would still be disposed of in an offsite TSCA landfill; however, soils with less than 50 mg/kg of PCBs or soils with PAHs greater than the PRGs would be consolidated onsite in a berm.

The berm would be constructed in the area between the existing East and West Containment cells on the northern portion of site. After consolidation of the soils and sediment is completed, the berm would be covered with 2 feet of clean soil and seeded.

#### **4.3.4 Soil Alternative 4—Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments**

Soil Media Alternative 4 (S4) is identical to S3 except for the disposal options. In S4, soils with less than 50 mg/kg of PCBs or soils with PAHs greater than the PRGs would be consolidated onsite in a berm, but the berm would be constructed along the entire length of the northern property boundary to allow future consolidation of Waukegan Harbor sediments.

New containment sidewalls would be constructed around the existing East and West Containment cells to allow placement of dewatered sediment and OMC Plant 2 soils directly on top. The cells would be modified, as necessary, to allow for the placement of the soil and sediment. After construction of the berm is complete, it would be covered with 10 inches of clean soil and seeded.

## **4.4 DNAPL Alternative Descriptions**

### **4.4.1 DNAPL Alternative 1—No Further Action**

The objective of the DNAPL Media Alternative 1 (D1), the No Further Action Alternative, is to provide a baseline for comparison to other alternatives, as required by the NCP.

Alternative D1 does not include any further remedial action for groundwater. It does not include monitoring or institutional controls.

### **4.4.2 DNAPL Alternative 2—Institutional Controls and Monitoring**

The objective of DNAPL Media Alternative 2 (D2) is to rely on institutional controls (ICs) to prevent exposure of residents or workers to DNAPL COCs and to use monitoring to evaluate whether exposures may be occurring. ICs include well drilling restrictions to prevent exposure to DNAPL. A restrictive covenant would be placed on the OMC property deed that would specify production wells not be installed within the DNAPL area. An IC would also be included to require use of subslab vapor control systems for any new structures placed over or in close proximity to the DNAPL area.

### **4.4.3 DNAPL Alternative 3—Extraction, Onsite Collection, and Offsite Destruction**

The objective of DNAPL Media Alternative 3 (D3) removal is to remove free-phase DNAPL to the extent practicable, resulting in a reduction of a secondary source of VOCs to the groundwater. Previous investigations have shown that measurable DNAPL is just east of the former metal working area.

The DNAPL removal system could be implemented as a standalone option or as a component of the groundwater extraction and treatment system. Designated DNAPL recovery systems would be installed in extraction wells where DNAPL has been identified during site investigation activities.

The designated DNAPL recovery systems would consist of DNAPL recovery pumps, DNAPL sensing probes, connecting pipes, controls, and storage tank. Operation of the DNAPL recovery system would be on a schedule determined by the recharge rate of DNAPL to the extraction well. Routine maintenance of the DNAPL sensing probes would be required. In addition, the contents of the storage tank would need to be pumped out periodically. The DNAPL is most likely a hazardous waste and would therefore be incinerated offsite at a RCRA Subtitle C TSCA facility.

### **4.4.4 DNAPL Alternative 4a—In Situ Chemical Reduction Treatment**

The objective of DNAPL Media Alternative 4a (D4a), in situ chemical reduction, is to incorporate amendments via shallow soil mixing to treat and stabilize DNAPL and increase the surface area of the DNAPL available to micro-organisms for anaerobic biological reductive dechlorination or chemical reduction. The increased surface area also accelerates the dissolution of DNAPL into the groundwater, allowing for more effective treatment by the selected groundwater remedy. The amendments would include ZVI and bentonite. The ZVI would corrode in situ releasing hydrogen, which then results in chemical reductive dechlorination of the CVOCs. The bentonite would be added to aid in the soil mixing by

reducing the torque needed to rotate the augers. In addition, it would reduce the permeability of the mixed soil so that the mass flux from any untreated residuals is greatly reduced. In situ soil mixing would be used to treat DNAPL areas accessible (i.e., outside the building) to the large equipment necessary to implement the alternative. DNAPL areas beneath the building may be addressed using this alternative after demolition of the building.

Large-diameter (6 feet or greater) augers would be advanced to the target depth. Upon reaching the target depth, the amendments would be injected through the augers. The augers would be advanced and retracted through the DNAPL interval several times to ensure complete mixing. This process would be repeated until the entire area had been treated.

Groundwater sampling of downgradient locations would be performed to monitor if a dissolved phase plume was generated as a result of soil mixing and monitor the changes in the plume, if any, over time.

#### **4.4.5 DNAPL Alternative 4b—In Situ Thermal Treatment**

DNAPL Media Alternative 4b (D4b) has the same objectives as D4a but uses in situ thermal treatment to reduce CVOC concentrations. ISTD could be implemented exclusively for DNAPL treatment or as a component of a larger scale system designed to treat the dissolved phase VOC plume. Thermal treatment would be accomplished using thermal desorption.

ISTD would use thermal wells, along with heated extraction wells. Heat would be applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer would be effective near the heating element. As a result, thermal convection and conduction would occur in the soil volume. The ISTD process would create a zone of very high temperature (greater than 1,000°F) near the heaters, which can oxidize or pyrolyze target constituents. ISTD would raise the soil temperature within the treatment volume to the boiling point of water, generating steam in situ. This would result in steam distillation of the contaminants. ISTD would occur as vapors are drawn into the hot regions in close proximity to heated extraction wells.

An SVE system would be used to remove volatilized constituents. SVE offgases would be treated in a catalytic oxidizer or similar treatment system.

#### **4.4.6 DNAPL Alternative 5—Excavation and Offsite Treatment and Disposal**

The objective of DNAPL Media Alternative 5 (D5) is to remove the DNAPL and DNAPL contaminated soil. To avoid excessive excavation, it is assumed that sheet piling would be installed to the surface of the till aquitard. The soil within the sheet piling would be excavated and stockpiled. Much of the overlying soil is assumed to be uncontaminated and could be sampled, analyzed, and replaced if it met cleanup levels. The excavation would be advanced to the depth of the DNAPL-contaminated soil. The DNAPL-contaminated soil would then be excavated and disposed of offsite as a hazardous waste. It is assumed that the DNAPL soil would require thermal treatment prior to disposal in a RCRA Subtitle C landfill.

The excavation would be backfilled with the nonhazardous shallow soils and clean fill materials. After the excavation was backfilled, the sheet piling would be removed.

## **4.5 Groundwater Alternative Descriptions**

Five groundwater media alternatives were developed to provide a range of remedial actions for groundwater contamination. The remaining technologies were incorporated into at least one alternative.

### **4.5.1 Groundwater Alternative 1—No Further Action**

The objective of the Groundwater Media Alternative 1 (G1), the No Further Action Alternative, is to provide a baseline for comparison to other alternatives, as required by the NCP. Alternative G1 does not include any further remedial action for groundwater. It does not include monitoring or institutional controls.

### **4.5.2 Groundwater Alternative 2—Institutional Controls and Monitored Natural Attenuation**

The objective of Groundwater Media Alternative 2 (G2) is to rely on natural attenuation for remediation of the groundwater plume. Natural attenuation is the process by which contaminant concentrations are reduced by volatilization, dispersion, adsorption, and biodegradation. Based on the site groundwater data, anaerobic conditions are present in the groundwater below the source area and at the plume perimeter. There is evidence of substantial biological degradation of the CVOCs.

The main remedial components of G2 include the following:

- Institutional controls
- MNA

#### **Institutional Controls**

ICs include well drilling restrictions to prevent exposure to contaminated groundwater. A restrictive covenant would be placed on the OMC property deed that would specify production wells not be installed within the plume or within areas in proximity to the plume that could affect plume migration. Restrictive covenants may also be necessary for properties south of the site if VOCs remain above the MCLs. An IC would also be included to require use of subslab vapor control systems for any new structures placed over or in close proximity to the plume area.

#### **Monitored Natural Attenuation**

MNA would be used to assess the degree of natural attenuation and allow estimates of the time necessary to reach PRGs. If monitoring data indicate further spreading of the plume above remedial goals along with a potential for adverse effects on receptors, active restoration with one of the remaining alternatives (G3, G4, or G5) would be implemented.

The objective of the monitoring program would be to collect sufficient information to track the lateral and vertical extent of the VOC contaminant plume, monitor changes in concentrations, and provide additional natural attenuation parameters to evaluate

biodegradation of the VOCs. The program would also allow assessment of continued releases from the source area.

The alternative includes development of a spreadsheet-based first-order decay rate natural attenuation model. This model would assist in development of a time estimate to reach PRGs.

### **4.5.3 Groundwater Alternative G3—Source Zone In Situ Treatment**

The objective of Groundwater Media Alternatives 3a and 3b (G3a and G3b) is to treat the VOC source areas and VOC groundwater plume (greater than 1 mg/L VOCs) in situ. In situ alternatives include in situ chemical reduction and enhanced reductive dechlorination. Each alternative is presented below.

#### **Groundwater Alternative G3a—In Situ Chemical Reduction**

The objective of Groundwater Media Alternative 3a (G3a) is to treat the VOC source areas and the VOC-contaminated groundwater plume (greater than 1 mg/L) by adding amendments to enhance existing anaerobic reducing conditions.

Insoluble chemical amendments (ZVI, carbon sources, or a combination) would be delivered to the aquifer in solid or slurry form. The amendments would create a zone of strongly reducing conditions, accelerating reductive dechlorination of the VOC contaminants. The addition of carbon sources can act as an enhancement to indigenous micro-organisms in the treatment zone, although this alternative is intended to rely primarily on abiotic chemical reduction.

#### **Groundwater Alternative G3b—Enhanced Reductive Dechlorination**

The objective of Groundwater Media Alternative 3b (G3b) is to treat the VOC source areas and VOC-contaminated groundwater plume (greater than 1 mg/L VOCs) by adding an organic substrate to stimulate the micro-organisms to metabolize the VOCs.

Enhanced reductive dechlorination is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade (metabolize) the VOCs, converting them to innocuous end products. Soluble nutrients or other amendments may be used to enhance reductive dechlorination and contaminant desorption from subsurface materials.

In the absence of oxygen (anaerobic conditions), the VOCs would be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate would be converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas would ultimately be produced.

### **4.5.4 Groundwater Alternative G4—Groundwater Collection and Treatment**

The objective of Groundwater Media Alternatives 4a and 4b (G4a and G4b) is to collect and treat the VOC-contaminated groundwater plume ex situ. G4a and G4b are differentiated by the groundwater VOC concentration at which the collection and treatment system would be shut down. G4a would continue extraction and treatment of the contaminated groundwater plume to a point where further reductions in concentrations have significantly diminished. Further reductions to PRGs would be by MNA. G4b would continue extraction and

treatment of the contaminated groundwater plume to VOC concentrations at or below MCLs.

#### **Groundwater Alternative G4a—Groundwater Collection and Treatment with Monitored Natural Attenuation**

The main remedial components of G4a include the following:

- Institutional controls
- Groundwater collection and treatment
- MNA

The ICs and MNA are as described for G2.

The objective of this component is to treat the VOC-contaminated groundwater plumes exceeding 1 mg/L total VOCs. The groundwater extraction treatment system would consist of extraction wells, extraction pumps, connecting piping, oil-water separator, controls, treatment train, building, and discharge piping, reinjection wells, or infiltration trenches. The goal of groundwater collection and treatment would be to maximize mass removal of VOCs from the groundwater over a reasonable time frame.

Groundwater treatment would consist of UV/oxidation, GAC, and/or air stripping. Air emission treatment would be included, if needed, to meet air permit levels. The treated groundwater would be discharged to either the POTW, reinjected, or discharged to surface water via a National Pollution Discharge Elimination System (NPDES) permit. The specific treatment and discharge technologies would be evaluated during alternative development and described in the FS.

Groundwater extraction would be continued until groundwater VOC concentrations reach a point where further reductions in concentrations have significantly diminished. Further reductions to PRGs would be by MNA based on first-order decay modeling. Natural attenuation monitoring would be performed on an annual basis.

#### **Groundwater Alternative G4b—Groundwater Collection and Treatment to MCLs**

G4b is identical to G4a other than the duration for which it would be operated and the lack of an MNA period. The objective of this alternative is to collect and treat the VOC-contaminated groundwater plume until drinking water MCLs are achieved. It is expected that this alternative may require operation for decades.

### **4.5.5 Groundwater Alternative G5—In Situ Thermal Treatment**

The objective of Groundwater Media Alternative 5 (G5) is to treat the source areas and dissolved VOC plume (concentrations greater than 1 mg/L).

ISTD would use thermal wells, along with heated extraction wells. Heat would be applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer would be effective near the heating element. As a result, thermal convection and conduction would occur in the soil volume. The ISTD process would create a zone of very high temperature (exceeding 1,000°F) near the heaters, which can oxidize or pyrolyze target constituents. An SVE system would be used to remove

volatilized constituents. Treatment of SVE offgas is assumed to be needed to meet air permit limits.

ISTD would raise the soil temperature within the treatment volume to the boiling point of water, generating steam in situ. This would result in steam distillation of the contaminants. ISTD would occur as vapors are drawn into the hot regions in close proximity to heated extraction wells.

The goal of ISTD would be treatment of source zones to reduce concentrations of VOCs to levels amenable to MNA within a reasonable time frame. The MNA performance is as described for G2.

## SECTION 5

# References

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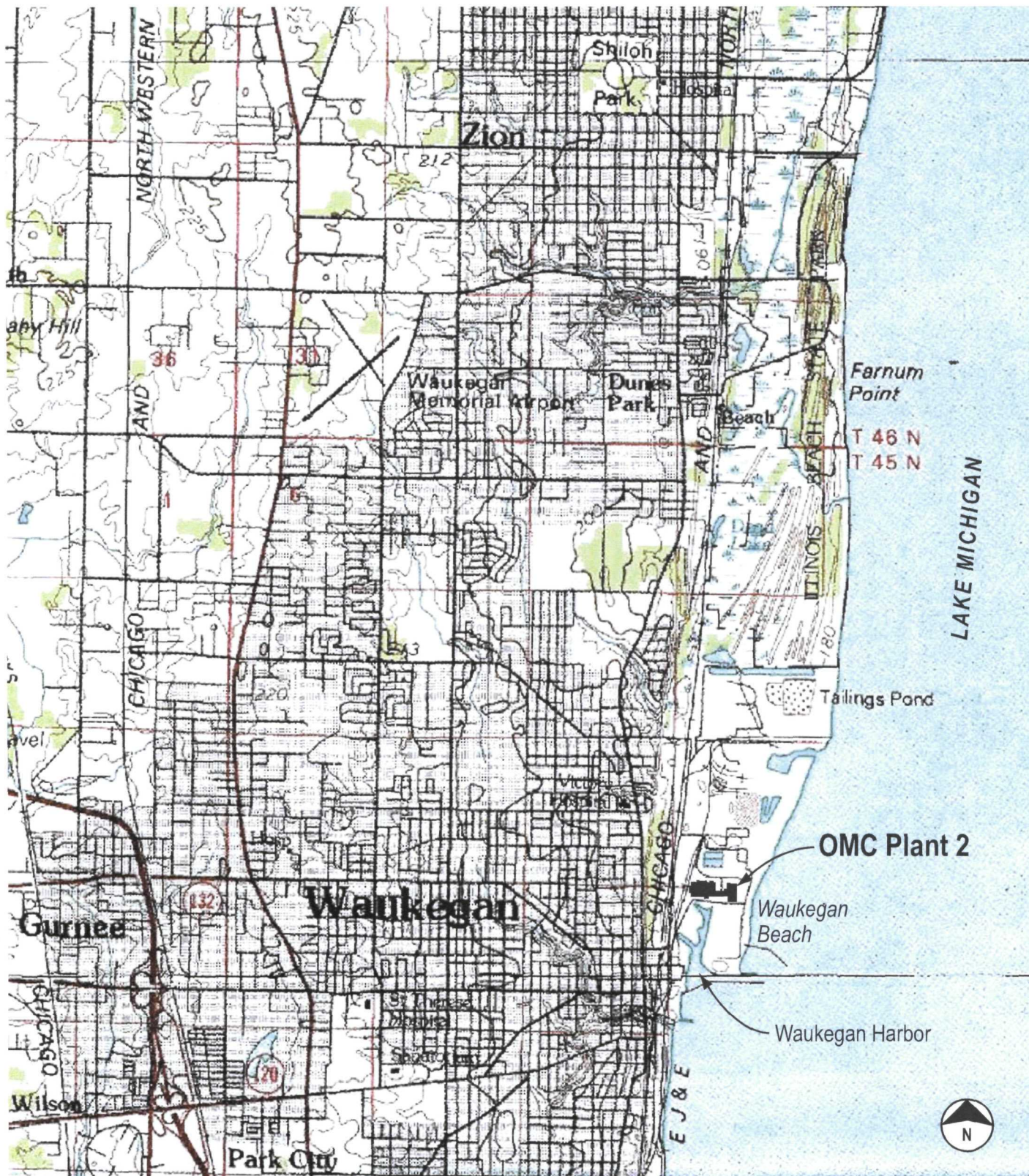
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## Figures

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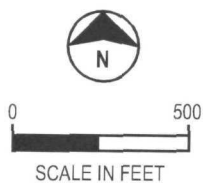
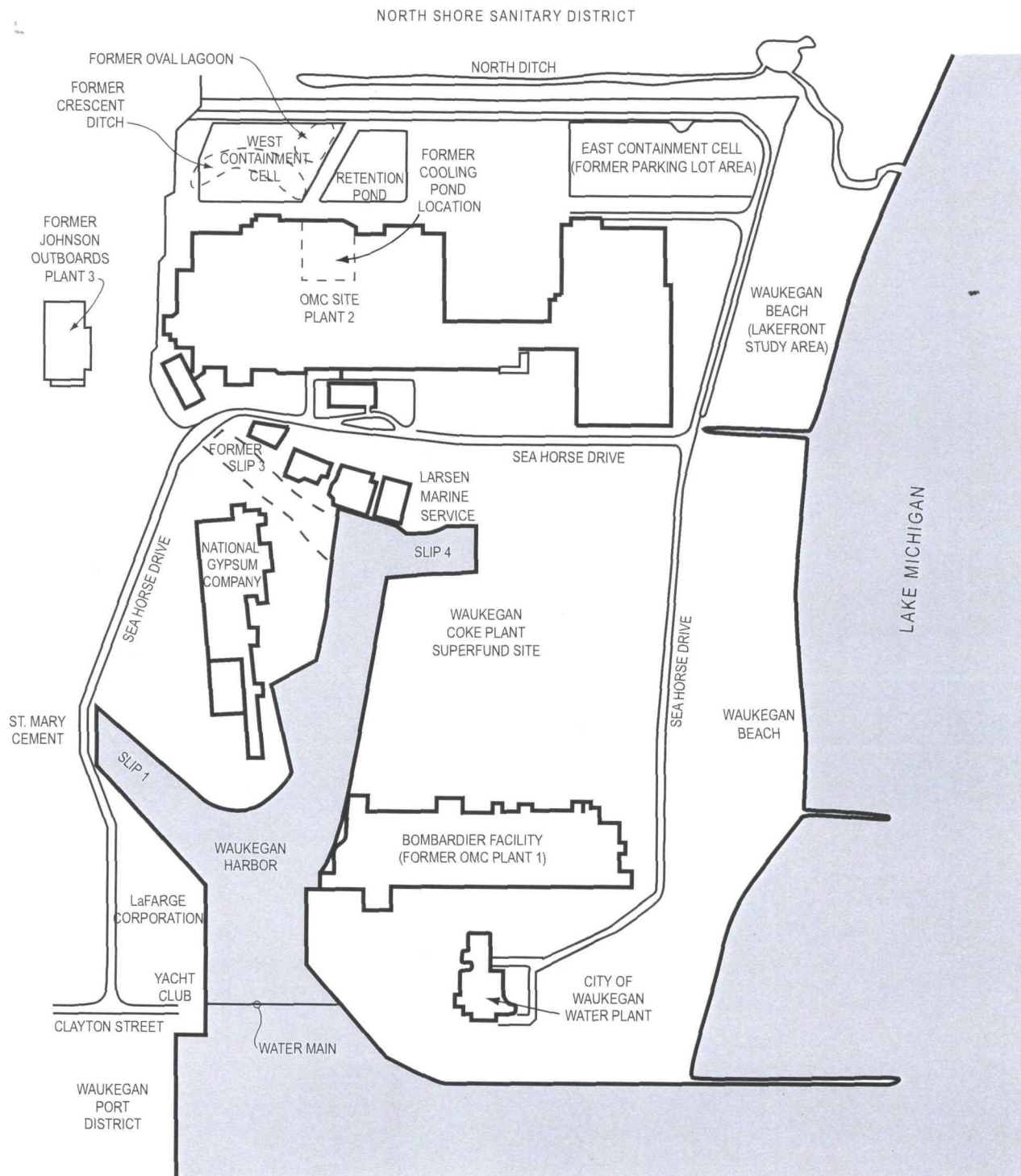
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SOURCE: USGS Waukegan Quadrangle Map

0 3,000  
SCALE IN FEET

Figure 1-1  
**Site Location Map**  
OMC Plant 2



SOURCE: ADAPTED FROM USEPA 2002

Figure 1-2  
**Vicinity Features**  
 OMC Plant 2



LEGEND

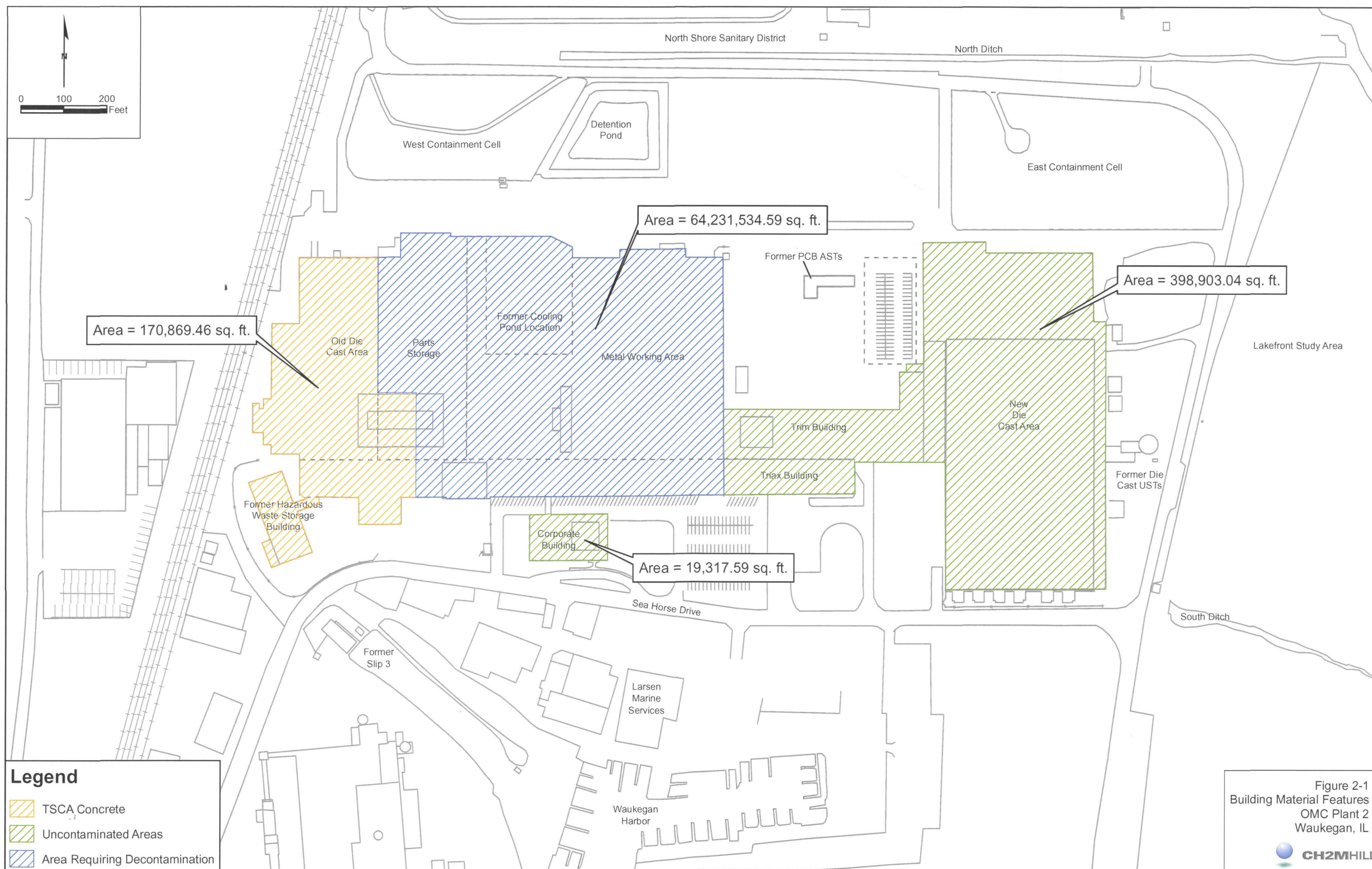
OMC Plant 2 Building Outline

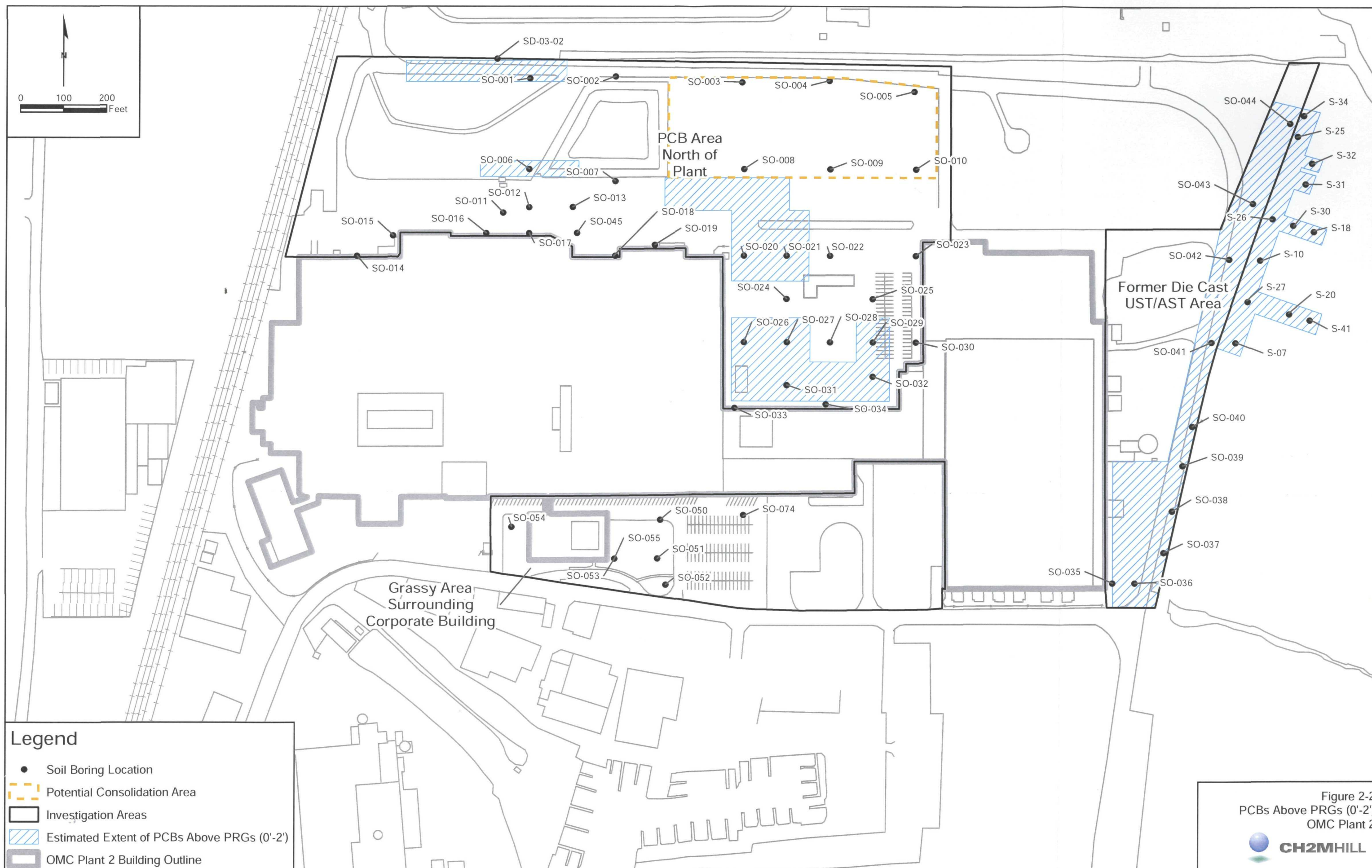


Source:  
Skidmore, Owings & Merrill LLP - Master Planning  
Conservation Design Forum - Ecological, Open Space and Landscape Planning  
Site Design Group, Ltd. - Park and Streetscape Concepts  
US Equities - Environmental Resource Identification

Sally Foster - Community Outreach  
Land Strategies, Inc. - Transportation Planning  
Development Concepts, Inc. - Market Analysis & Development Strategies  
CH Johnson Consulting - Economic & Market Analysis

Figure 1-3  
**Waukegan Lakefront-Downtown  
Master Plan/Urban Design Plan**  
OMC Plant 2  
**CH2MHILL**



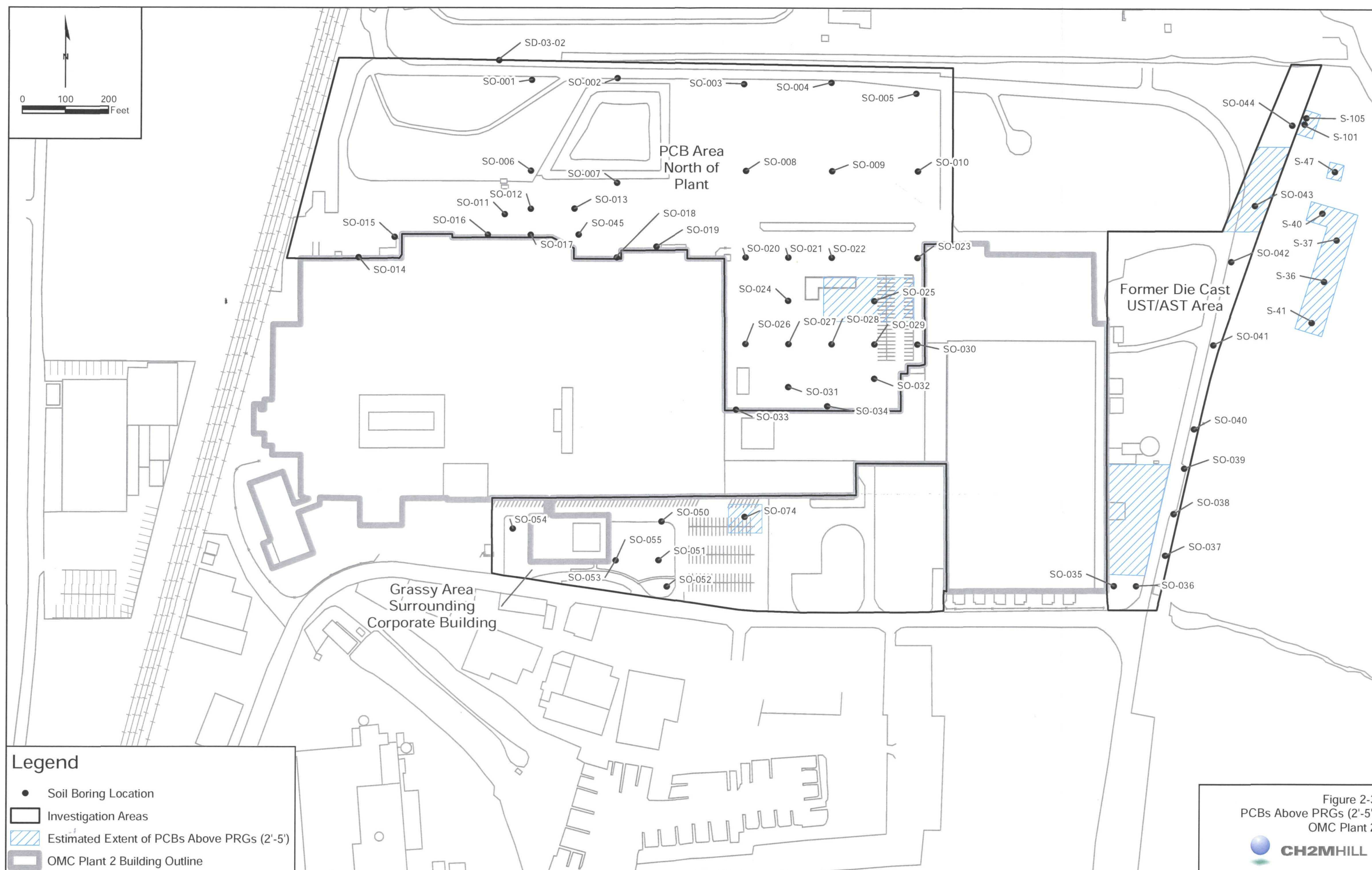


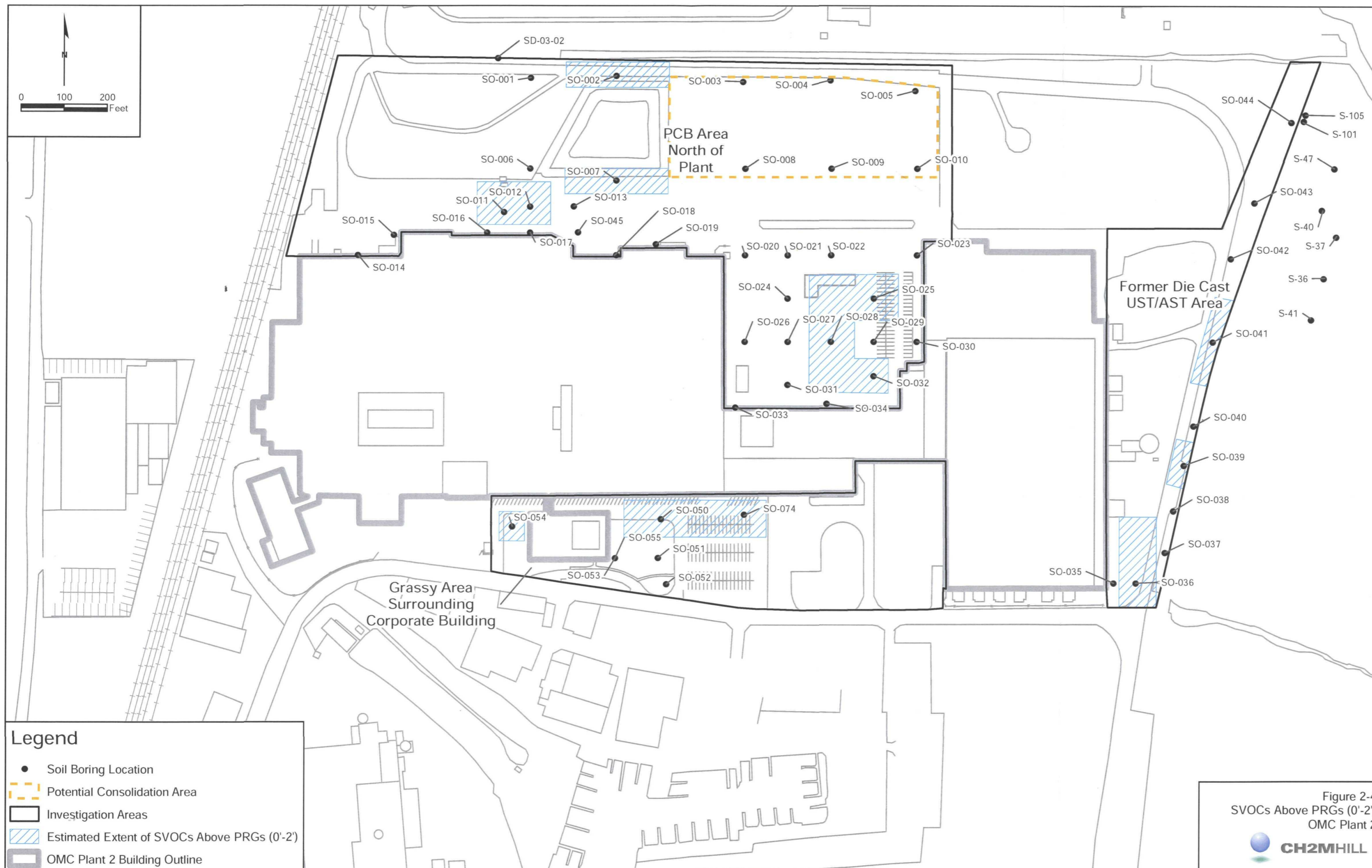
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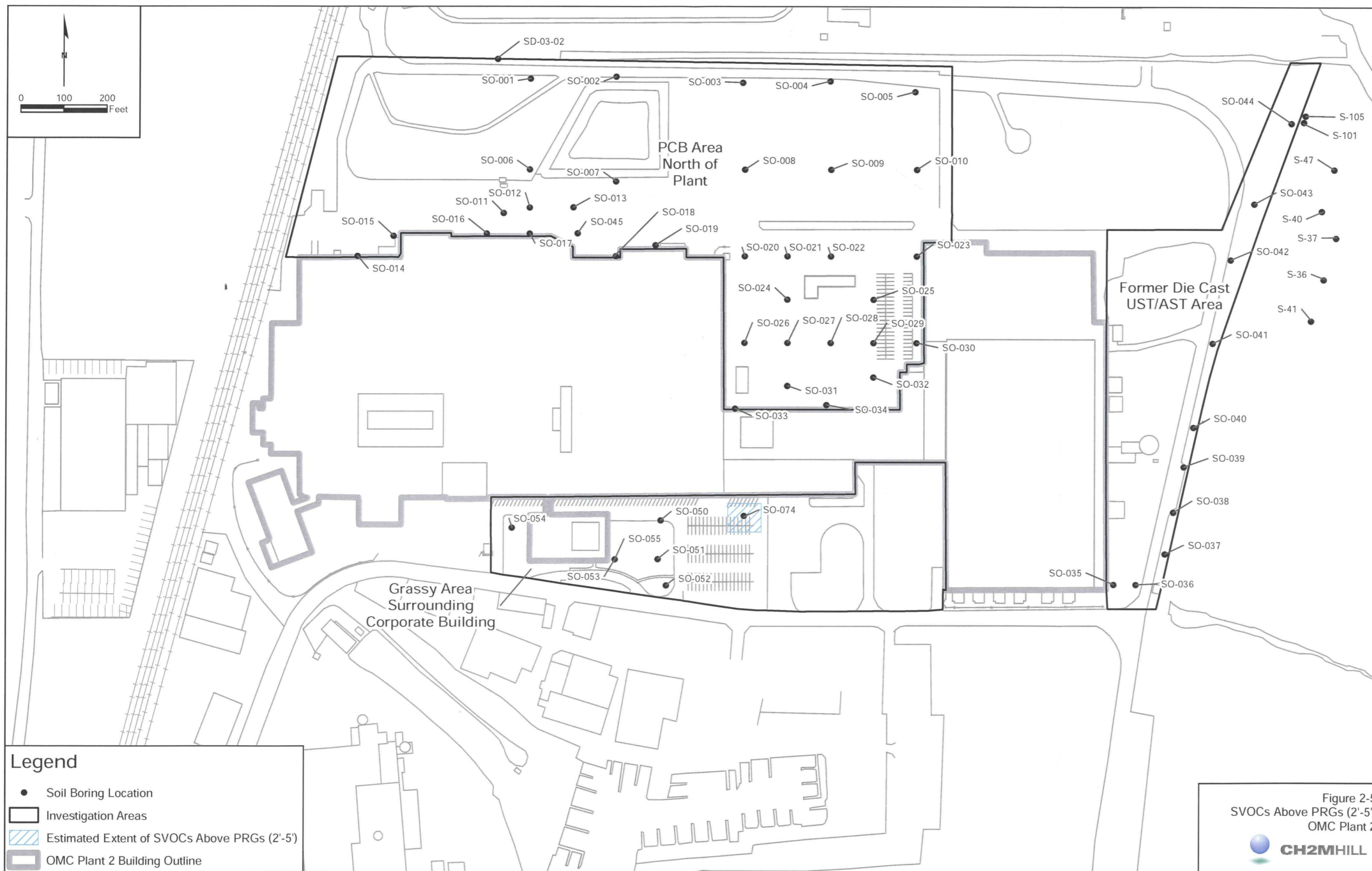
- Soil Boring Location
- - - Potential Consolidation Area
- ▭ Investigation Areas
- ▨ Estimated Extent of PCBs Above PRGs (0'-2')
- ▬ OMC Plant 2 Building Outline

Figure 2-2  
PCBs Above PRGs (0'-2')  
OMC Plant 2

CH2MHILL







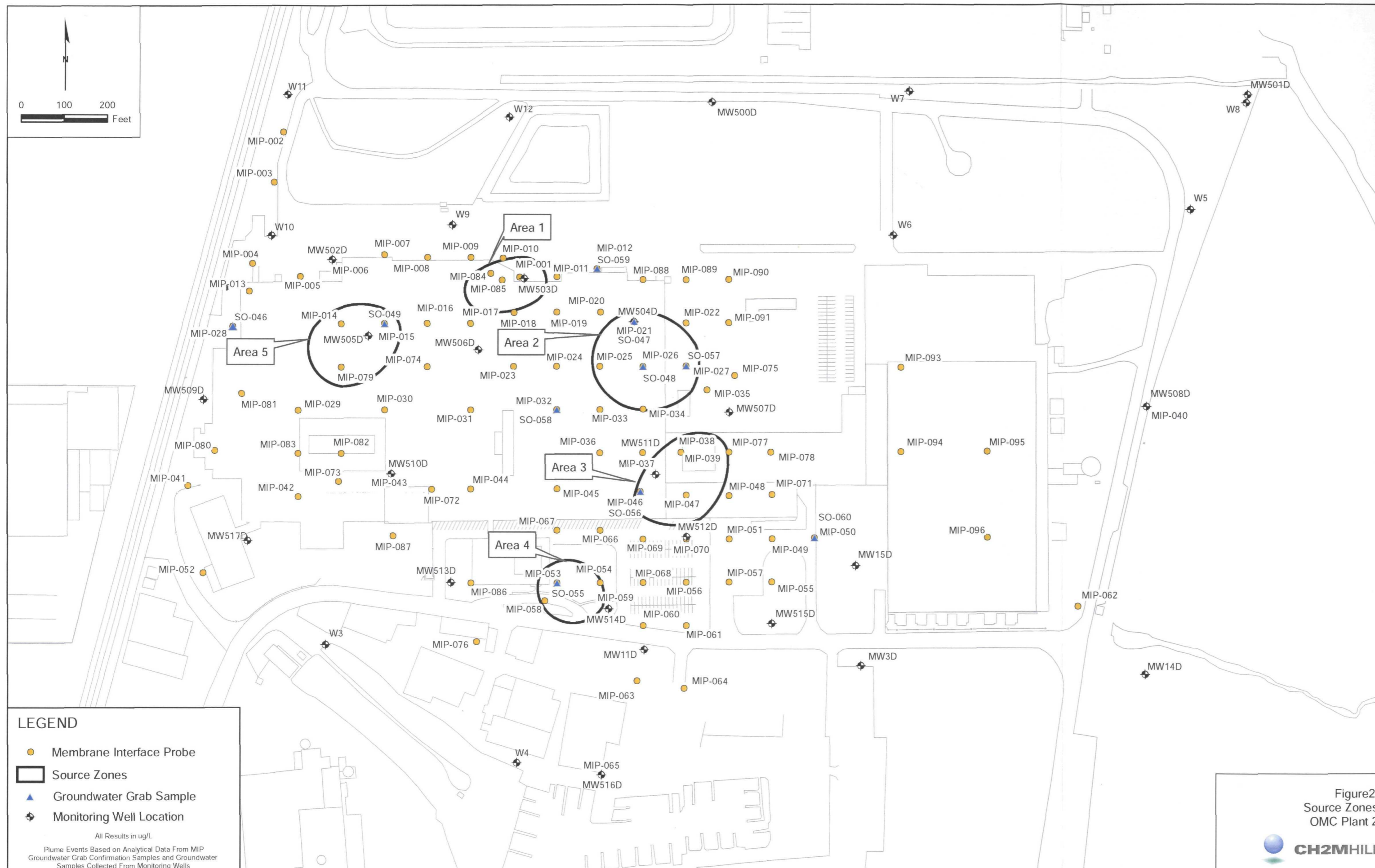




Figure 2-7  
Deep Groundwater Total  
CVOC Concentrations  
OMC Plant 2



**Appendix A**  
**Evaluation of ARARs**

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**APPENDIX A**  
ARARs  
OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
<b>Chemical-Specific ARARs</b>			
<b>Soil and Groundwater</b>			
TSCA	Establishes requirements and thresholds for management of PCBs.	ARAR	TSCA is relevant and appropriate to defining the management of PCBs in soils. TSCA is applicable to remedial actions managing soils contaminated with PCBs (see action-specific ARARs).
CERCLA Guidance on Land Use in the CERCLA Remedy Selection Process	Establishes appropriate considerations in defining future land use.	TBC	Provides guidance to EPA in selecting land use for remedy selection purposes.
Illinois Administrative Code (IAC) Title 35, Part 742, Tiered Approach to Corrective Action Objectives (TACO)	TACO establishes a framework for determining soil and groundwater remediation objectives standards and for establishing institutional controls. Tier 1 remediation objectives are set at $10^{-6}$ ELCR and HI =1 values. Section 742.900(d) Tier 3 remediation objectives allows cleanup levels within the ELCR range of $10^{-4}$ to $10^{-6}$ .	TBC	TACO is a voluntary program and is not required (Part 742.105 (a)). It provides guidance for development of site-specific soil and groundwater remediation objectives. Will be used to establish preliminary remediation goals.
<b>Groundwater</b>			
Safe Drinking Water Act (SDWA)— Maximum Contaminant Levels (MCLs) 40 CFR 141.61 (organic chemicals) 40 CFR 141.62 (inorganic chemicals)	CERCLA 121(d) states that a remedial action will attain a level under the SDWA. MCLs are enforceable maximum permissible level of a contaminant which is delivered to any user of a public water system.	ARAR	MCLs are relevant and appropriate for potential drinking water sources per the NCP. Remedies may not have to demonstrate compliance with an ARAR that is technically impracticable (see NCP), such as areas of DNAPL.
SDWA—Maximum Contaminant Level Goals (MCLGs) 40 CFR 141.50 (organic chemicals) 40 CFR 141.51 (inorganic chemicals)	CERCLA 121(d)(2)(A) states that a remedial action attain MCLGs where relevant and appropriate. MCLGs are non-enforceable health goals under the SDWA.	ARAR	Non-zero MCLGs may be relevant and appropriate. MCLGs equal to zero are not appropriate for cleanup of groundwater or surface water at CERCLA sites by EPA policy (see NCP).
SDWA—Secondary MCLs (SMCLs) 40 CFR 143	Non-enforceable limits intended as guidelines for use by states in regulating water supplies. Secondary MCLs are related to aesthetic concerns (e.g. taste and odor) and are not	TBC	SMCLs may be considered if drinking water use of aquifer is considered feasible.

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### ARARs

#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
	health-related.		
Office of Drinking Water. Drinking water health advisories.	Guidance levels for drinking water issued by Office of Drinking Water	TBC	May be used for chemicals without MCLs if groundwater is to meet drinking water quality.
IAC Title 35, Part 620 Illinois Water Quality Standards (IWQS); Part 620.210; 620.410; IWQS Class I: Potable Resource Groundwater	Groundwater must meet the standards appropriate to the groundwater class as specified in Subpart D/Section 620.401-440.  Standards for potential potable water supply.	ARAR	Applicable to site groundwater. Site groundwater is a class I potable resource groundwater. Not applicable to groundwater 10 feet or less from ground surface or to groundwater from low permeability formations ( $k < 1 \times 10^{-4}$ cm/s or $< 150$ gpd from a well screened over 15 foot thickness). Remedies considered for the site may include development of a groundwater management zone (GMZ) which may allow contaminant concentrations higher than designated for Class I groundwater.
IAC Title 35, Part 620.220; 620.420; IWQS Class II: General Resource Groundwater	Applicable to groundwater compatible with agricultural, industrial, recreational, or beneficial uses and not in Classes I, III, or IV.	ARAR for groundwater within 10 feet of ground surface.	Not an ARAR for most of the shallow groundwater because groundwater is Class I. Applicable for groundwater 10 feet or less from ground surface.
IAC Title 35, Part 620.450(a), Alternative Groundwater Quality Standards - Groundwater Quality Restoration Standards	Applies to groundwater within a groundwater management zone. May allow concentrations higher than designated use after remediation.	ARAR	Applicable if a GMZ is used.
Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, OSWER Directive No. 9234.2-25, dated September 1993.	Applies to groundwater at contaminated sites. Establishes criteria for assessing the technical impracticability of groundwater remediation.	TBC	Groundwater in area of DNAPL may make groundwater restoration technically impracticable.
<b>Surface Water</b>			
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 208(b)	Establishes water quality criteria for specific pollutants for the protection of human health and aquatic life. These federal water quality criteria are non-enforceable guidelines used by the state	TBC	Water quality criteria are TBCs used in setting standards for discharges to surface water from a treatment system.

APPENDIX A  
ARARs  
OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
40 CFR Part 131–Water Quality Standards	to set water quality standards for surface water.		
40 CFR Part 132	40CFR Part 132 provides guidance for setting discharge limits for bioaccumulative contaminants such as PCBs.	TBC	Water quality criteria are TBCs used in setting standards for discharges to surface water from a treatment system. Discharge limits for PCBs will likely be set at nondetectable levels.
Pretreatment Standards 40 CFR403	Pretreatment standards for the control of pollutants discharged to POTWs. The POTW should have either an EPA approved program or sufficient mechanism to meet the requirements of the national program in accepting CERCLA waste.	Possible ARAR	ARAR if groundwater is discharged to the Northshore Sanitary District POTW.
Great Lakes Initiative (GLI), Clean Water Act 33 U.S.C. §§1251-1387 at 33 U.S.C. 1268, as amended by the Great Lakes Critical Programs Act (Public Law 101-546)	GLI establishes water quality standards, antidegradation policies, and implementation procedures with which state standards must comply for waters in the Great Lakes System.	ARAR	GLI establishes the basis for Illinois State Standards for Lake Michigan water quality.
IAC Title 35, Part 302, Illinois Water Quality Standards General Use - Subpart B Sections 302.201-212	Section 11 of Environmental Protection Act – Regulations to restore, maintain, and enhance purity of the water of the state.  Waters of state for which there is no specific designation <ul style="list-style-type: none"> <li>• acute standards apply within mixing zone</li> <li>• chronic apply after mixing zone</li> </ul>	ARAR	Apply to Illinois surface waters that do not have a specific use category.
IAC Title 35, Part 302, Public and food processing water supply—Subpart C; Sections 302.301-305	Applies to waters of state designated for waters drawn for treatment and distribution as a potable supply or food processing at the point of withdrawal.	ARAR	For Lake Michigan at point of water withdrawal
IAC Title 35, Part 302, Subpart E: Lake Michigan Water Quality Standards. Section	Applicable to waters of Lake Michigan and the Lake Michigan Basin.	ARAR	Subpart E is for Lake Michigan. Lake Michigan Basin standards are applicable

**APPENDIX A****ARARs****OMC Plant 2 Feasibility Study**

Regulation	Requirement	ARAR Status	Analysis
302.501-509.			to the harbor and lake adjacent to the site.
IAC Title 35, Part 303, Subpart C: Specific Use Designations and Site Specific Water Quality Standards, Section 303.443.	Defines standards for "open waters" and "other waters" of the Lake Michigan Basin	ARAR	Lake Michigan Basin standards are applicable to the harbor and lake adjacent to the site.
IAC Title 35, Part 304 Effluent Standards	Designates specific effluent limits for discharges to surface water.	Possible ARAR	ARAR if remedial alternative includes discharge to surface water. Substantive requirements must be met for discharges to surface water of treatment system water.
IAC Title 35, Part 309 Permits	Designates process used in setting NPDES effluent limits for discharges to surface water.	Possible ARAR	ARAR if remedial alternative includes discharge to surface water. Substantive requirements must be met for discharges to surface water of treatment system water.
IAC Title 35, Part 307 Sewer Discharge Criteria, 1101-1103 General and Specific Pretreatment Requirements.	Designates general requirements for discharges to POTWs such as no discharge of pollutants which pass through the POTW or interfere with the operation and performance of the POTW. Also gives specific limits for discharge of certain pollutants.	Possible ARAR	ARAR if remedial alternative includes discharge to POTW. Substantive requirements must be met for discharges to Northshore Sanitary District POTW of treatment system water.
IAC Title 35, Part 310 Pretreatment Programs. 310.201-202.	Designates general requirements for discharges to POTWs such as no discharge of pollutants which pass through the POTW or interfere with the operation and performance of the POTW. Also requires POTWs to develop Pretreatment programs.	Possible ARAR	ARAR if remedial alternative includes discharge to POTW. Used by Northshore Sanitary District in setting pretreatment discharge requirements for discharge of treatment system water.
<b>Air</b>			
IAC Title 35, Subtitle B: Air Pollution	Regulations contain specific requirements that pertain to allowable emissions of criteria pollutants from a number of air contaminant source categories and processes.	Possible ARAR	ARAR if remedial alternative results in air emissions. Substantive requirements for air emission control must be met.
IAC Title 35, Part 212 Visible and Particulate	Regulations contain specific requirements that pertain to allowable emissions of fugitive	ARAR	Dust control must be implemented to control visible particulate emissions during

**APPENDIX A**  
**ARARs**  
*OMC Plant 2 Feasibility Study*

Regulation	Requirement	ARAR Status	Analysis
Matter Emissions	particulate matter.		construction activities.
IAC Title 35, Part 245 Odors	Regulations specify how to determine whether a nuisance odor is present.	ARAR	Odor control may be necessary if it is determined that a nuisance odor is present.
<b>Location-Specific ARARs</b>			
Coastal Zone Management Act 16 USC §1451 et. seq.  15 CFR 930	Requires that Federal agencies conducting activities directly affecting the coastal zone conduct those activities in a manner that is consistent, to the maximum extent practicable, with approved State coastal zone management programs.	ARAR	Applicable to construction in the coastal zone.
Endangered Species Act of 1973 16 USC §1531 et seq. 50 CFR 200	Requires that Federal agencies insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	ARAR	In the future redevelopment scenario, potential risks to threatened and endangered plant species that may colonize created habitat are present. Risks are a result of the current concentrations of SVOCs and PAHs in soil.
Rivers and Harbors Act of 1899 Section 10 (33 USC §401et. seq.)  33 CFR 403 33 CFR 322	Requires approval from USACE for dredging and filling work performed in a navigable waterway of the U.S. Activities that could impede navigation and commerce are prohibited.	Not likely ARAR	Dredging or filling are not likely components of remedial alternatives at OMC Plant 2.
National Historical Preservation Act 16 USC §661 et seq.  36 CFR Part 65	Establishes procedures to provide for preservation of scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. If scientific, historical, or archaeological artifacts are discovered at the site, work in the area of the site affected by such discovery will be halted pending the completion of any data recovery and preservation activities required pursuant to the act and its implementing	Not likely ARAR	May be ARAR during the remedial activities if scientific, historic, or archaeological artifacts are identified during implementation of the remedy.

**APPENDIX A**

## ARARs

## OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
Protection of Wetlands—Executive Order 11990 50 CFR Part 6, Appendix A	regulations.  Requires actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If none is available, effects from implementing the chosen alternative must be mitigated. Public notice and review of activities involving wetlands is required.	ARAR	The ecological risk assessment concluded that wetlands or aquatic habitat are not present onsite. Small wetlands were identified along the north and south ditches between the site and Lake Michigan.
Executive Order 11988 50 CFR Part 6, Appendix A	Requires actions to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains.	TBC.	Site not within floodplain.
Great Lakes Water Quality Initiative Part 132, Appendix E	Provides guidance to Great Lakes states regarding wastewater discharge, stating that lowering of water quality standards via wastewater discharge should be minimized.	TBC	Considered as guidance.
Rivers and Harbors Act. 33 CFR Part 332, Section 10.	A permit is required for work in or affecting navigable waters of the U.S. This includes dredging, disposal of fill material, filling or modification of said waters below the ordinary high water level (OHWL).	Not likely ARAR	Remedial actions are not likely to include activities within harbor or Lake Michigan.
<b>Action-Specific ARARs/TBC</b>			
Fish and Wildlife Coordination Act (16 USC 661 et seq.)	The Act provides protection and consultation with the U.S. Fish and Wildlife Service and state counterpart for actions that would affect streams, wetlands, other water bodies, or protected habitats. Action taken should protect fish or wildlife, and measures should be developed to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies that may affect the drainage ditches.

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#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
Occupational Safety and Health Act (29 U.S.C. 61 et seq.)	The Occupational Safety and Health Act was passed in 1970 to ensure worker safety on the job. The U.S. Department of Labor oversees the Act. Worker safety at hazardous waste sites is specifically addressed under 29 CFR 1910.120: Hazardous Waste Operations and Emergency Response; general worker safety is covered elsewhere within the law.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies.
Clean Air Act; National Ambient Air Quality Standards (NAAQS) Section 109  40 CFR 50-99	<p>The Clean Air Act is intended to protect the quality of air and promote public health. Title I of the Act directed the USEPA to publish national ambient air quality standards for "criteria pollutants." In addition, USEPA has provided national emission standards for hazardous air pollutants under Title III of the Clean Air Act. Hazardous air pollutants are designated hazardous substances under CERCLA.</p> <p>The Clean Air Act amendments of 1990 greatly expanded the role of National Emission Standards for Hazardous Air Pollutants by designating 179 new hazardous air pollutants and directed USEPA to attain maximum achievable control technology standards for emission sources. Such emission standards are potential ARARs if remedial technologies (such as incinerators or air strippers) produce air emissions of regulated hazardous air pollutants.</p> <p>Specifies requirements for air emissions such as particulates, sulfur dioxide, VOCs, hazardous air pollutants, and asbestos.</p>	ARAR	The Act is considered an ARAR for remedies that involve creation of air emissions, such as excavation activities that might create dust or treatment systems that might emit volatile organic compounds.
Hazardous Materials Transportation Act; 49 CFR 100-109 Transportation of hazardous materials.	Specific DOT requirements for labeling, packaging, shipping papers, and transport by rail, aircraft, vessel, and highway.	Possible ARAR	Off-site shipment of hazardous waste may occur.
Resource Conservation and Recovery Act	RCRA was passed in 1976. It amended the Solid	Possible ARAR	There is no documented evidence of

## APPENDIX A

### ARARs

#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
(RCRA), (42 U.S.C. 321 et seq.)	Waste Disposal Act by including provisions for hazardous waste management. Authority for implementation of RCRA in Illinois was given to the State of Illinois. See Illinois ARARs below under Title 35 IAC Parts 720 to 730.		disposal of listed hazardous waste at the site. Soil excavated for onsite ex situ treatment or offsite disposal may however be characteristic hazardous waste. See Illinois ARARs below for more details of specific requirements.
40 CFR 268 Land Disposal Restrictions	The land disposal restrictions require treatment before land disposal for a wide range of hazardous wastes.	Possible ARAR	ARAR for disposal of hazardous waste. Applicable to soils that are a characteristic hazardous waste or that contain a listed waste. Contaminated soils must meet the higher of 10 x the universal treatment standard or a 90% reduction of the contaminant concentration.
Toxic Substances Control Act (TSCA) 15 U.S.C. 2601 et seq.)	The Toxic Substances Control Act, created in 1976, instituted a range of control measures, primarily record-keeping and reporting requirements, to document the production and use of hazardous chemicals, primarily polychlorinated biphenyls.	ARAR	The Act applies to remedies that involve sites with polychlorinated biphenyl contamination.
Toxic Substances Control Act (TSCA) PCB Remediation Wastes; 40 CFR 761.61	Specifies requirements for self-implementing on-site cleanup of PCB remediation waste.	TBC	Requirements are not binding on CERCLA sites (761.61 (a)(1)(ii)).
TSCA Cleanup Levels. (761.61(a)(4)	<p>Bulk remediation waste cleanup levels are as follows:</p> <p>High occupancy areas- &lt; or = 1 ppm (&lt; or = 10 ppm if capped with 6 inch concrete or asphalt or 10 inches compacted soil);</p> <p>Low occupancy areas- &lt; or = 25 ppm</p> <p>Non-porous surfaces cleanup levels are:</p> <p>High occupancy areas- &lt; or = 10 ug/100cm<sup>2</sup></p> <p>Low occupancy areas- &lt; 100 ug/100cm<sup>2</sup></p>	TBC	Requirements are not binding on CERCLA sites (761.61 (a)(1)(ii)).

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ARARs  
OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
	Porous surfaces		
	Same as bulk remediation wastes		
TSCA Site Cleanup. (761.61(a)(5)(B)(2)(iii).	<p>Bulk remediation waste:</p> <p>PCBs &gt; 50 mg/kg must be disposed of in a TSCA chemical waste landfill or a RCRA hazardous waste.</p> <p>PCBs &lt; 50 mg/kg may be disposed in Subtitle D Solid Waste landfill permitted for this waste.</p> <p>Non-porous material:</p> <p>Unpainted metal structures or piping may be sold as scrap if PCBs &lt; 10 ug/100cm<sup>2</sup>.</p> <p>Painted non-porous material may be sold as scrap if there is no visible indications of PCB contamination and PCBs &lt; 10 ug/100cm<sup>2</sup>.</p> <p>Metal structures or piping can be smelted directly or disposed in a Subtitle D Solid Waste landfill permitted for this waste if PCBs &gt; 10 ug/100cm<sup>2</sup> and &lt; 100 ug/100cm<sup>2</sup>.</p> <p>Metal structures or piping must be thermally treated in a scrap metal recovery oven or disposed in a Subtitle C Hazardous Waste or TSCA chemical waste landfill if PCBs &gt; 100 ug/100cm<sup>2</sup>.</p> <p>Metal structures or piping may be decontaminated on-site prior to sale to reduce PCB concentrations to below 100 ug/100cm<sup>2</sup>.</p> <p>Porous material other than Floors (e.g., painted metal, concrete block walls):</p> <p>May be disposed onsite or in a Subtitle D Solid</p>	ARAR	<p>Excavated soils for offsite disposal with PCBs &gt; 50 mg/kg will be disposed in accordance with these requirements.</p> <p>Non-porous and porous material will be disposed in accordance with TSCA requirements.</p>

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#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
	<p>Waste landfill if there is no visible indications of PCB contamination and PCBs &lt; 10 ug/100cm<sup>2</sup>.</p> <p>If PCBs &gt; 10 ug/100cm<sup>2</sup> and core or chip samples &lt; 50 mg/kg waste can disposed onsite or in a Subtitle D Solid Waste landfill.</p> <p>If PCBs &gt; 10 ug/100cm<sup>2</sup> and core or chip samples &gt; 50 mg/kg waste must be disposed in a Subtitle C Hazardous Waste or TSCA chemical waste landfill.</p>		
TSCA Performance-based Cleanup (761.61(b)(3)).	Material that has been dredged or excavated from waters of the United States must be managed in accordance with a permit issued under section 404 of the Clean Water Act, or the equivalent of such a permit.	Not an ARAR	Excavation or dredging of PCB contaminated sediment is not included in the OMC Plant 2 operable unit.
TSCA (40CFR 761.65) Storage for Disposal	Bulk PCB remediation waste containing > 50 mg/kg PCBs may be stored onsite for up to 180 days, provided controls are in place for prevention of dispersal by wind or generation of leachate. Storage site requirements include a foundation below the liner, a liner, a cover, and a run-on control system.	ARAR	ARAR for excavated soils with PCBs > 50 mg/kg that are stored onsite. An extension on the 180-day storage limit could be obtained if needed through a notification to EPA per 40 CFR 761.65 (a).
IAC Title 35, Environmental Protection, Subtitle B: Air Pollution	This part describes permits and emission standards to protect air quality.	ARAR	This part is considered an ARAR for remedies that involve creation of air emissions, such as excavation activities that might create dust or treatment systems that might emit volatile organic compounds.
IAC Title 35, Part 212, Subpart K, Fugitive Particulate Matter.	Site construction and processing activities would be subject to Sections 212.304 to .310 and .312 which relate to dust control.	ARAR	Remedial action may generate fugitive dust. Rules require dust control for storage piles, conveyors, on-site traffic, and processing equipment. An operating program (plan) is required and is to be designed for significant reduction of fugitive emissions.

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## ARARs

### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Part 218, Organic Material Emission Standards and Limitations for the Chicago Area (includes Lake County); Subpart C: Miscellaneous Equipment; 218.141 Separation Operations	Air pollution control requirements for effluent water separator receiving effluent water with more than 200 gal/day of free-phase organic material.	Not an ARAR	Not an ARAR. On-site wastewater treatment is not likely to treat organic pure phase liquids at rates exceeding 200 gal/day.
IAC Title 35, Part 218, Organic Material Emission Standards and Limitations for the Chicago Area (includes Lake County); Subpart K: Use of Organic Material; 218.301-.303	The discharge of greater than 8 lbs/hr of VOC from any emission unit is prohibited.	Not an ARAR	Not an ARAR. The discharge of greater than 8 lbs/hr of VOC from any aspect of the remedial action is not likely.
IAC Title 35, Part 228 Asbestos	Requirements to limit asbestos emissions from a variety of sources including demolition.	Possible ARAR	Building demolition would need to consider presence of asbestos and limit emissions if present. Excavation of soil is not expected to uncover asbestos containing material.
IAC Title 35, Subtitle G: Waste Disposal, Subchapter c: Hazardous Waste Operating Requirements, Parts 720- 729.	<p>RCRA was passed in 1976. It amended the Solid Waste Disposal Act by including provisions for hazardous waste management. The statute sets out to control the management of hazardous waste from inception to ultimate disposal. RCRA is linked closely with CERCLA, and the CERCLA list of hazardous substances includes all RCRA hazardous wastes.</p> <p>RCRA applies only to remedies that generate hazardous waste. IEPA has been given authorization to implement RCRA in Illinois.</p> <p>Standards applicable to hazardous waste generators, transporters and operators of hazardous waste treatment storage and disposal facilities.</p>	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for onsite ex situ treatment or offsite disposal may however be characteristic hazardous waste.
IAC Title 35, Subchapter c, Hazardous waste Operating Requirements; Part 721 Identification and listing of hazardous waste.	Soils must be managed as hazardous waste if they contain listed hazardous waste or are characteristic hazardous waste. Management of treatment residuals subject to RCRA if residuals	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for onsite ex situ treatment or offsite disposal may however

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Regulation	Requirement	ARAR Status	Analysis
	retain characteristic.		be characteristic hazardous waste.
IAC Title 35, Subchapter c, Part 722; Standards applicable for generators of hazardous waste.	Establishes regulation covering activities of generators of hazardous wastes. Requirements include ID number, record keeping, and use of uniform national manifest.	Possible ARAR	Applicable if wastes are RCRA hazardous and go off-site.
IAC Title 35, Subchapter c, Part 723 Standards applicable for transporters of hazardous waste.	The transport of hazardous waste is subject to requirements including DOT regulations, manifesting, record keeping, and discharge cleanup.	Possible ARAR	Applicable if wastes are RCRA hazardous and go off-site.
IAC Title 35, Subchapter c, Part 724.110 to 724.119 Subpart B—General Facility Standards.	General requirements and application of section 264 standards.	Not likely an ARAR	Applicable if A RCRA hazardous waste disposal facility is constructed onsite.
IAC Title 35, Subchapter c, Part 724.190 to 724.201 Subpart F—Releases from Solid Waste Management Units.	Requirements for wastes contained in solid waste management units.	TBC	Investigation and remediation is performed under the USEPA Superfund program with RCRA requirements for SWMUs as TBCs.
IAC Title 35, Subchapter c, Part 724.210 to 724.220 Subpart G—Closure and Post-closure	General closure and post-closure care requirements. Closure and post-closure plans (including operation and maintenance), site monitoring, record keeping, and site use restriction.	TBC	RCRA is not an ARAR for closure of site because site is not a RCRA hazardous waste treatment, storage or disposal facility. Hazardous wastes are not known to be present onsite.
IAC Title 35, Subchapter c, Part 724.270 to 724.279 Subpart I—Use and Management of Containers	Standards applicable for owners and operators of hazardous waste facilities that store containers of hazardous waste.	Possible ARAR	ARAR if remedy uses containers for storage of hazardous waste.
IAC Title 35, Subchapter c, Part 724.290 to 724.300 Subpart J—Tank Systems	Standards applicable for owners and operators that use tank systems for storing or treating hazardous waste.	Possible ARAR	ARAR if remedy uses tanks for storage of hazardous waste such as liquids which exceed TCLP limits.
IAC Title 35, Subchapter c, Part 724.320 to	Standards applicable for owners and operators	Not a likely ARAR	Surface impoundments are not likely a

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### ARARs

#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
724.332 Subpart K—Surface Impoundments	that use surface impoundments to treat, store or dispose of hazardous waste.		remedial action.
IAC Title 35, Subchapter c, Part 724.350 to 724.359 Subpart L—Waste Piles	Requirements for hazardous waste kept in piles. Requirements include liner, leachate collection unless in a container or structure.	Not likely an ARAR	Waste piles are not likely a remedial action.
IAC Title 35, Subchapter c, Part 724.370 to 724.383 Subpart M—Land Treatment	Standards applicable for owners and operators of facilities that treat or dispose of hazardous waste in land treatment units.	Not likely an ARAR	Land treatment is not likely a remedial action.
IAC Title 35, Subchapter c, Part 724.400 to 724.417 Subpart N—Landfills	Regulations for owners and operators of facilities that dispose of hazardous waste in landfills. Requirements for design, operation, and maintenance of hazardous waste landfills.	Not likely an ARAR	Not an ARAR. Landfill not a likely remedial action.
IAC Title 35, Subchapter c, Part 724.440 to 724.451 Subpart O—Incinerators	Standards applicable for owners and operators of hazardous waste incinerators.	Not likely an ARAR	On-site incineration is not a likely remedial action.
IAC Title 35, Subchapter c, Part 724.650 to 724.655 Subpart S—Special Provisions for Cleanup	Standards applicable for corrective action management units, temporary units and staging piles.	ARAR	Staging piles or temporary units may be needed for soil that may be a characteristic hazardous waste.
IAC Title 35, Subchapter c, Part 724.700 to 724.703 Subpart X—Miscellaneous Units	Standards applicable for owners and operators that treat, store or dispose of hazardous waste in miscellaneous units.	Not likely an ARAR	Other units for treatment, storage or disposal of hazardous waste are not likely to be a part of remedial actions.
IAC Title 35, Subchapter c, Part 728	Identifies land disposal restrictions and treatment requirements for materials subject to restrictions on land disposal. Must meet waste-specific treatment standards prior to disposal in a land disposal unit.	Possible ARAR	ARAR for disposal of hazardous waste. Applicable to soils that are a characteristic hazardous waste or that contain a listed waste. Contaminated soils must meet the higher of 10 x the universal treatment standard or a 90% reduction of the contaminant concentration.

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Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Environmental Protection, Subtitle G: General Provisions, Chapter I: Pollution Control Board, Subchapter d: Underground Injection Control and Underground Storage Tank Programs; Part 730 and 738	Underground injection control and underground storage tank programs.	ARAR	These regulations would be an ARAR for remedies involving use of wells for injection of materials to accelerate remediation or reinjection of treated groundwater, remedies that require installation of an underground storage tank or remedies that reinject treated water.
IAC Title 35, Subtitle G: Subchapter f: Part 740 Site Remediation Program,	Presents requirements for the site remediation program.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105- Applicability).
IAC Title 35, Subtitle G: Subchapter f: Site Remediation Program, Section 740.530 Establishment of Groundwater Management Zones.	Presents requirements for establishment of groundwater management zones (GMZ). GMZs are three dimensional areas where groundwater exceeds the groundwater standards of 35 IAC Part 620.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105- Applicability).
IAC Title 35, Subtitle G: Subchapter f: Site Remediation Program, Section 740.535 Establishment of Soil Management Zones.	Presents requirements for establishment of soil management zones (SMZ). SMZs can be used for onsite placement of contaminated soils for structural fill or land reclamation or consolidation of contaminated soils within a remediation site. Soil with contaminants exceeding criteria cannot be placed in areas of soil meeting criteria.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105- Applicability).
IAC Title 35, Subtitle G: Subchapter f: Part 742. Tiered Approach to Remedial Action Objectives.	The purpose of this part is to establish the procedures for investigative and remedial activities at sites where there is a release, threatened release, or suspected release of hazardous substances, pesticides, or petroleum, and for the review of those activities; establish procedures to obtain IEPA review and approval of remediation costs for the environmental remediation tax credit; and establish and administer a program for the payment of remediation costs as a brownfield site.	TBC	TACO is a voluntary program and is not required (Part 742.105 (a)). Provides guidance for development of site-specific soil and groundwater remediation objectives. Will be used to establish preliminary remediation goals.

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**ARARs**  
*OMC Plant 2 Feasibility Study*

Regulation	Requirement	ARAR Status	Analysis
	Presents requirements for the tiered approach to corrective action objectives (TACO). Tier 1 remediation objectives are set at $10^{-6}$ ELCR and $HI = 1$ values. Section 742.900(d) Tier 3 remediation objectives allows cleanup levels within the ELCR range of $10^{-4}$ to $10^{-6}$ .		
IAC Title 35, Subtitle G: Subchapter f: Tiered Approach to Remedial Action Objectives. Subpart J Institutional Controls, Part 742.1000 to 742.1020.	Provides requirements for when ICs are needed and presents requirements for implementation of ICs. ICs are needed when land use is assumed to be industrial or commercial, risk exceeds a $HI = 1$ or $ELCR > 1 \times 10^{-6}$ , engineered barriers are used, exposure routes are excluded or when the point of exposure requires control.	TBC	Provides guidance for development of ICs. TACO is a TBC since it is not required.
IAC Title 35, Subtitle G: Subchapter f: Tiered Approach to Remedial Action Objectives. Subpart J Engineered Barriers, Part 742.100 to 742.1105.	<p>Provides requirements for engineered barriers. Barriers include the following:</p> <p>Soil component of groundwater pathway: 1) caps or walls consisting of clay, asphalt, or concrete 2) permanent structures such as buildings, or highways.</p> <p>Soil ingestion pathway: 1) caps or walls consisting of clay, asphalt, or concrete, 2) permanent structures such as buildings, or highways; or 3) uncontaminated soil, sand or gravel that is at least 3 feet in thickness.</p> <p>Soil inhalation pathway: 1) caps or walls consisting of clay, asphalt, or concrete, 2) permanent structures such as buildings, or highways; or 3) uncontaminated soil, sand or gravel that is at least 10 feet in thickness.</p>	TBC	Provides guidance for development of ICs. TACO is a TBC since it is not required.
IAC Title 35, Subtitle G: Subchapter h; Illinois "Superfund" Program. Part 750 Illinois Hazardous Substances Pollution Contingency	Establishes requirements for investigation and remediation of sites where there has been a release or a substantial threat of a release of a	TBC	Not an ARAR. The Illinois Hazardous Substances Pollution Contingency Plan is applicable to State response taken at sites

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### ARARs

#### OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
Plan.	hazardous substance. Parallels US EPAs Superfund program.		which are not the subject of a federal response taken pursuant to CERCLA.
IAC Title 35, Parts 807-810 Solid Waste and Special Waste Hauling	This part describes requirements for solid waste and special waste hauling. Special waste must be treated, stored or disposed at a facility permitted to manage special waste. Presents the special waste classes and the method to determine whether the solid waste is a special waste and if so, whether it is Class A (all non-Class B special wastes) or Class B (low or moderate hazard special wastes). RCRA hazardous waste is not included within the special waste classes.	ARAR	ARAR for disposal of solid waste and special waste. Contaminated soil that is not a RCRA hazardous waste would be evaluated to determine whether it is a Class A or B special waste. Offsite disposal of special waste must be at a Solid Waste landfill permitted to receive that special waste class unless IEPA specifically allows otherwise.
IAC Title 35, Part 811 Applies to all new landfills.	Requirements for new solid waste landfills.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart A—General Standards for All Landfills	Location standards, operating standards, closure and post-closure maintenance.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart C—Putrescible and Chemical Waste Landfills General	Location standards, liner and leachate collection system requirements, final cover requirements.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart C—Putrescible and Chemical Waste Landfills Facility Location (811.302)	Location of landfill including setback zone, proximity to sole source aquifer, residences, schools, hospitals or runways.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subtitle H: Part 900 Noise	Regulations contain specific requirements that pertain to nuisance noise levels.	Possible ARAR	ARAR. Noise levels will need to be controlled if noise reaches nuisance levels.
Lake County Stormwater Management Commission, Watershed Development Ordinance	Regulations specify performance standards for stormwater control.	ARAR	ARAR. Remedial actions need to be evaluated relative to stormwater controls if they disturb more than 5,000 sf of soil. <a href="http://www.co.lake.il.us/smc/regulatory/wdo/docs.asp">http://www.co.lake.il.us/smc/regulatory/wdo/docs.asp</a>

**Appendix B**  
**Sewer Sampling and Result**

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# **Storm Sewer Sediment Investigation OMC Plant 2 (Operable Unit 4), Waukegan, Illinois WA No. 237-RICO-0528, Contract No. 68-W6-0025**

PREPARED FOR: USEPA  
PREPARED BY: CH2M HILL  
DATE: March 28, 2006

## **Introduction**

This memorandum documents the activities associated with the storm sewer sediment investigation at the Outboard Marine Corporation Plant 2 (OMC Plant 2) site in Waukegan, Illinois. The investigation activities were conducted on November 21, 2005, to supplement the visual sewer inspections and sewer testing conducted in 2005. This additional investigation included sediment probing and the collection and analysis of saturated sediments from eight storm sewer manholes.

This memorandum includes the following:

- Description of specific field activities performed, including locations and methods
- Summary of the samples collected, requested analyses, and analytical results
- Description of materials encountered at each location

## **Sediment Investigation**

Sediment samples were collected from seven storm sewer locations (Figure 1) located south of OMC Plant 2 and analyzed for polychlorinated biphenyls (PCBs). The objectives of the sediment sampling included:

- Define the thickness of sediment in the storm sewers south the plant
- Determine PCB concentrations in the sediment in the storm sewer manholes
- Evaluate if PCBs in the storm sewer sediments may act as a continuing source of PCBs to Waukegan Harbor and the South Ditch

## **Sampling Procedures**

Following a review of site maps and a visual inspection of the area south of the OMC building, eight storm sewer manhole locations were identified as sample locations. The storm sewer locations were selected for sediment sampling based on proximity to Waukegan Harbor and/or the South Ditch and locations downgradient of areas at the OMC plant, which historically used PCBs in operations.

**TABLE 1**  
 Storm Sewer Sediment Sampling Summary  
 OMC Plant 2 Remedial Investigation

Storm Sewer Manhole ID	Sediment Thickness (inches)	Water Present in Manhole?	Sheen Observed During Sampling?	Total PCBs (mg/kg)
1662	8.0	Yes	Yes	130
1663	30.0	Yes	Yes	3.1
1861	4.0	Yes	No	2.8
1913	4.0	Yes	No	0.9
7	24.0	Yes	Yes	3.0
8	6.0	No	N/A	0.2
9	6.0	Yes	Yes	1.9

Aroclor 1248 was the only PCB aroclor detected in samples.  
 N/A - not applicable due to absence of water in manhole during sampling.

